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ROHDE & SCHWARZ
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Operating Manual

RADIO-SET TEST ASSEMBLY SMPU

239.0010

The description consists of:

Operating Manual
Servicing Manual
Parts Lists and Plans

Printed in West Germany
Zusammengestellt nach R 30890
Übersetzung von nach R 30570

1.

Before starting to use your new Rohde & Schwarz equipment, don't forget to read the most important part of this manual: the operating instructions.

Using the compilation list (ZV), the list at the back, you can check whether the manual is complete and complies with the given amendments (ÄZ). If you have any complaints, please state the "R" number of the ZV and the particular "Position" number.

Upon request you can have a second copy of the manual sent to you free of charge by filling out and returning the postcard below; this offer is valid for six weeks from the date you receive the equipment.

2.

We would like to enter your name in our customer files so that we can keep you informed of our latest developments. We are also interested in learning what the main factor was that made you decide to buy this particular R&S equipment. You can help us in this by returning the postcard below.

Many thanks in advance and, most of all, happy hours with your R&S equipment.

ROHDE & SCHWARZ

3.

For spare parts contact your nearest R&S representative or apply directly to Rohde & Schwarz, D 8000 Munich 80, Postfach 80 14 69, Federal Republic of Germany; telephone: (089) 41 29-465; telex: 5 23 703; telegram: rohde-schwarz muenchen.

When ordering spare parts please state:

- Code and R&S stock number of the component (see parts list)
- Type, order designation and serial number (FNr.) of the equipment
- Full address for delivery

☐ The manual for the equipment mentioned on reverse side is incomplete. Please send for ZV number .....

.....

the following position numbers

.....

☐ Please send a second copy of the manual. It is required for
- ☐ library/documentation
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Name and address:

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ROHDE & SCHWARZ

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R 14 500

R&S equipment ..... date of receipt .....

type ..... order designation .....

I learnt of it through*:

News from R&S, advertisement, catalog, data sheet, press report, advertizing circular, visit by representative, personal recommendation, exhibition, demonstration bus, tender, other: .....

.....

Reason for purchase*:

Technical superiority, lifetime, easy operation, price, serviceable design, R&S service, experience with other R&S equipment, other: .....

.....

* Please underline answers

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1. Characteristics

1.1 Uses

The automatic Radio-Set Test Assembly SMPU is the basic unit of a system which enables automation of measurements on RT equipment. The SMPU can be used as a semi-automatic test assembly without additional programming equipment ensuring an extremely good rationalization effect. A built-in microcomputer considerably simplifies the operation compared with conventional manual test setups. Since fixed test routines are incorporated, complex and time-consuming measurement of, for instance, bandwidth and sensitivity can be made automatically.

The SMPU is fully programmable and can be augmented by using control peripherals. The simplest programming aid is the Card Reader PCL which enables setting of measuring and operating data and calling of measurements by means of program cards. Thus the SMPU can be operated by unskilled staff. To ensure fully automatic operation with data logging the SMPU can be augmented by a desk-top calculator. In this way, a favourably priced fully automatic test assembly for radio sets is obtained.

Meeting the highest requirements with respect to flexibility, augmentation by additional measuring instruments, ease of programming and convenient data input/output, the SMPU is used in the Automatic Test System ATS-A-SF which is especially suitable for goods-outwards inspection in large-batch production of RT equipment. The SMPU alone or combined with a card reader or desk-top calculator can be used to advantage in large servicing shops and in small-batch production of RF equipment.

In addition to goods-outwards inspection of RT equipment, the measuring instruments incorporated in the SMPU can also be used for module testing.

1.2 Description

The SMPU comprises the following programmable measuring instruments required for checking RT equipment:

RF synthesizer, 200 kHz to 500 MHz
AF generator, 10 Hz to 100 kHz
Modulator for AM/FM/φM
Attenuator set, up to 141 dB
Automatic frequency and phase deviation meter
Modulation depth meter (option)
RF frequency counter, 40 kHz to 500 MHz (resolution 10 Hz)
AF frequency counter, 50 Hz to 40 kHz (resolution 1 Hz)
AF level meter, 3 mV to 10 V
Distortion meter
RF power meter, up to 50 W
Psophometric weighting filter

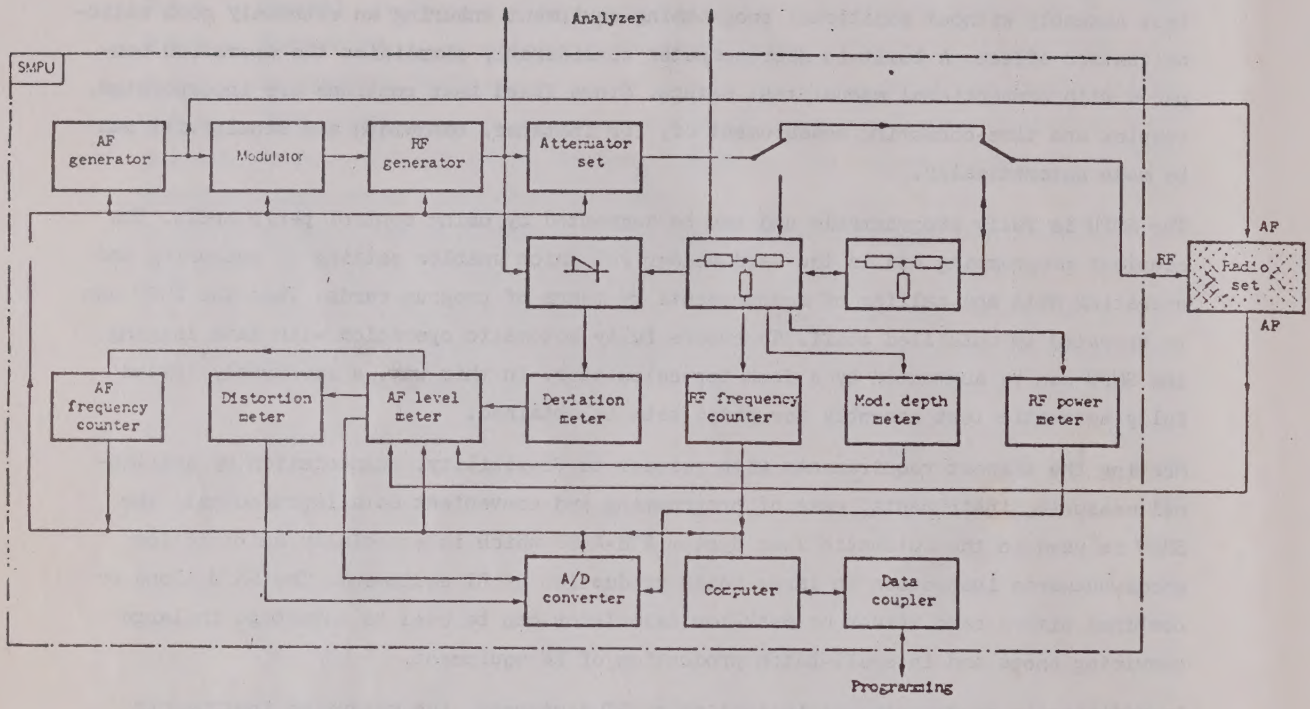


Fig. 1-1 Simplified diagram of Radio-Set Test Assembly SMPU

The measuring instruments of the SMPU are controlled by a built-in microcomputer. It constitutes the link between the measuring instruments and the operator and thus facilitates operation of the test assembly. In addition, it controls the measuring instruments (e.g. automatic deviation meter tuning), digitizes various test results (e.g. distortion measurement) and enables the execution of complete test routines (e.g. sensitivity and bandwidth measurements). Thus the SMPU constitutes an assembly which integrates individual measuring instruments and the computer control.

In contrast to other computer-controlled test systems, the software stored in the SMPU cannot be modified. It covers only recurrent measurements and parameters in accordance with CEPT standards. Since the SMPU is fully programmable, additional test routines which are not stored in the SMPU can be executed by external programming.

The SMPU is programmed in ASCII via a data bus. The same bus is used for data output in ASCII. This data bus is designed in accordance with the IEC standards for test equipment programming so that an easy and problem-free combination with other standard measuring instruments and control equipment is possible.

1.3 Specifications

RF generator

Frequency range ..... 0.05 - 499.99999 MHz
Resolution of frequency setting ..... 10 Hz
Error limits ..... see crystal
Spectral purity
  Harmonics ..... down > 26 dB
  Spurious responses ..... down > 86 dB
  S/N ratio (referred to 1 Hz bandwidth)
    at ±20 kHz from signal ..... > 120 dB
    at ±200 kHz from signal ..... > 125 dB
Output EMF ..... 0.09 µV - 1 V (-141 to 0 dBV)
Source impedance ..... 50 Ω, VSWR < 1.2
Resolution of level setting ..... 1 dB
Error limits ..... ±1 dB (0.2 - 500 MHz)

Crystal

Instability due to temperature effect .. $< 2 \times 10^{-9}/°C$
Warmup time ..... max. 15 min
Aging ..... $< 5 \times 10^{-8}$/month
External control ..... 10 MHz; 0.5 V into 50 Ω

Modulation

Types ..... AM, FM and φ M

Internal modulation generator

Frequency range ..... 10 Hz - 99.9 kHz
Frequency setting ..... three decades
Error limits of frequency setting ..... ±2%
Distortion ..... < 1% up to 20 kHz (2% up to 50 kHz)
Output EMF ..... 10 mV_{rms} - 7 V_{rms}
Resolution of AF level setting ..... 10 mV
Error limits of level setting ..... ±2% up to 20 kHz
Source impedance ..... 50 Ω

Amplitude modulation

Modes ..... int. or ext. generator
Modulation depth ..... 0 - 99%
Resolution of modulation depth setting . 1%
Error limits of modulation depth setting ..... ±3% at f_{mod} = 1 kHz

Frequency response ..... ±3% (0 - 20 kHz) ±5% (20 - 50 kHz)

Frequency range ..... 0 - 50 kHz

Envelope distortion at 90% modulation ..... ≦ 3%
at 80% modulation ..... ≦ 2%

Level requirement for external AM ..... 1 V (rms)

Frequency modulation

Modes ..... int. or ext. generator; synchronized and free-running

Frequency deviation ..... 0 - 99.9 kHz

Resolution of deviation setting ..... 100 Hz

Error limits of deviation setting ..... ±4% at f_{mod} = 1 kHz

Frequency response ..... ±3% (0 - 20 kHz), ±6% (20 - 100 kHz)

Modulation frequency range ..... 20 Hz - 100 kHz (synchronized)
0 Hz - 100 kHz (not synchronized)

Envelope distortion ..... < 1% (int.), < 0.3% (ext.)

Incidental AM up to 20 kHz frequency deviation ..... < 1%

Level requirement for external FM ..... 1 V (rms)

Phase modulation

Modes ..... same as for FM

Phase deviation ..... 0 - 10 rad

Resolution of phase deviation setting ..... 0.1 rad

Additional frequency response ..... ±2%

Modulation frequency range ..... 100 Hz - 6 kHz

RF overload protection ..... switches automatically to transmitter measurement when RF power is applied

Maximum permissible RF power ..... 50 W (25 W)

Frequency measurement+)

RF measurement:

Frequency range ..... 40 kHz - 500 MHz

Sensitivity of test input (minimum input level) ..... 10 mV at < 300 MHz
50 mV at > 300 MHz

Maximum input level ..... 3 V

Power input (level range)..... 0.1 - 25 (50) W

Indication ..... eight digits

Resolution ..... 10 Hz

Error limits of indication ..... see crystal

AF measurement:

Frequency range ..... 50 Hz - 40 kHz

Minimum input level ..... 1 mV

Maximum input level ..... 10 V

+) does not apply to Models for Receiver Measurements 239.0010.53 and .54

Indication ..... five digits

Resolution ..... 1 Hz

Error limits of indication ..... see crystal

Frequency deviation measurement[+)] (positive and negative deviation can be measured separately)

Frequency range ..... 1 - 500 MHz (automatic tuning)

Sensitivity of test input
(minimum input level) ..... 50 mV at < 300 MHz
100 mV at > 300 MHz

Maximum input level ..... 3 V

Power input (level range) ..... 0.1 - 25 (50) W

Deviation ranges ..... 5/20 kHz (useful deviation, peak value)
50/200 Hz (residual FM, rms value)

Modulation frequency range ..... 50 Hz - 19 kHz, without weighting filter

with weighting filter ..... according to CCITT

Indication ..... on mirror-scale meter

Error limits (f_{mod} = 0.1 - 10 kHz) ..... ± (2.5% of rdg + 0.5% of f.s.d) digital output
± (1.5% of rdg + 1.5% of f.s.d.) for meter

AF output level ..... 1 V at f.s.d.

Phase deviation measurement[+)]

Phase deviation ranges ..... 2/5 rad (useful deviation, peak value)
0.02/0.05 rad (residual PM; rms value)

Modulation frequency range ..... 300 Hz - 6 kHz

Additional frequency response ..... ±2%

Other data ..... see frequency deviation measurement

Modulation depth measurement (only if Modulation Depth Meter SMPU-Z1 240.0326.02 is built in)

Ranges 0.3/1/30/100%

Error limits
(for power levels > 100 mW) ..... ± (3% of rdg + 1.5% of f.s.d.) for meter
± (4% of rdg + 0.5% of f.s.d) for digital output

AF output level ..... 1 V at f.s.d.

AF level measurement

Ranges ..... 3/10/30/100/300 mV/1/3/10 V (in 10-dB steps)

Input impedance ..... 10 kΩ

Indication ..... on meter with dB and V calibration

Error limits ..... ± (2.5% of rdg + 1.5% of f.s.d.) for meter
± (3% of rdg + 0.5% of f.s.d) for digital output

Type of rectification ..... rms-responsive

Frequency range ..... 50 Hz - 20 kHz without weighting filter

with weighting filter ..... according to CCITT

[+)] see page 8

Power measurement[+)]

Ranges ..... 0.25 (0.5)/2.5 (5)/25 (50) W; switch-selected

Error limits ..... ± (6% of rdg + 1.5% of f.s.d) for meter
± (6% of rdg + 1% of f.s.d) for digital output

Frequency range ..... 10 - 525 MHz

Distortion measurement

Test frequency ..... 0.3/1 kHz

Indication ..... three digits

Resolution 0.1%

Indication range ..... 0.1 - 99%

Minimum input level ..... 100 mV

Error limits ..... ± (2% of rdg + 1 digit)

DC voltage measurement

Range ..... 0 - 5 V (measured data available only via digital output)

Resolution ..... 5 mV

Error limits ..... ±1% ±1 digit

Modes

Manual control ..... programming inhibited

Programmed operation ..... keyboard locked

Combined mode ..... simultaneous programmed and manual operation, possibility of overlaying

Programming and data output

Code ..... ASCII

System ..... IEC bus

Transfer time ..... 2 - 50 µsec per character

Output time ..... approx. 250 µsec per character

Connector ..... 24-contact Amphenol

Resolution of data variation (knob or program command)

Frequency: RF ..... 10 Hz/1 kHz/100 kHz

AF ..... third decade

Level: RF ..... 1 dB

AF ..... 10 mV

Modulation depth 1%

Frequency deviation ..... 100 Hz

Phase deviation ..... 0.1 rad

► Incorporated fixed programs
(fully automatic program execution, pushbutton-selected)

+) see page 8

Bandwidth - positive deviation

Bandwidth - negative deviation

Measurement of frequency difference between positive or negative 6-dB point and centre frequency, taken at 10-dB noise attenuation

Measurement time ..... approx. 12 sec

Indication of measured value ..... seven digits

Resolution ..... 100 Hz

Sensitivity - 20 dB

Sensitivity - 12 dB

Input level measurement for 20-dB or 12-dB S/N ratio or SINAD ratio (switch-selected)

Measurement time ..... approx. 8 sec

Indication of measured value ..... three digits

Resolution ..... 1 dBV

Lower squelch response level (input level at which the squelch is switched off)

Upper squelch response level (input level at which the squelch is switched on)

Measurement time ..... approx. 10 sec for lower level
approx. 15 sec for upper level

Indication of measured value ..... three digits

Resolution ..... 0.1 or 0.2 dB

S/N ratio

Measurement of S/N ratio or SINAD ratio with previously set input level

Measurement time ..... < 0.5 sec

Indication of measured value ..... three digits

Resolution ..... 0.1 or 0.2 dB

General data

Nominal temperature range ..... +10 to +45°C

Shelf temperature ..... -20 to +70°C

AC supply ..... 115/125/220/235 V ±10%, 250 VA

Overall dimensions (W x H x D),
cabinet model ..... Control Unit: 484 mm x 328 mm x 509 mm
Indicator: 484 mm x 283 mm x 509 mm

Weight (cabinet model) ..... 80 kg

Order Nos.

19" cabinet model 239.0010.52

19" rackmount 239.0010.51

Model for Receiver Measurements:

19" cabinet model 239.0010.54

19" rackmount 239.0010.53

1.4 Accessories Supplied

1 power cable DS 025.2365
1 lamp lifter 239.4444
1 multipoint connector FM 018.6075
1 shell (for multipoint connector) FM 018.6052
1 termination (50 Ω) 244.7677
1 cable 239.9081
1 cable 239.9098
4 RF connecting cables 100.6945
1 RF cable 239.0090
1 label 41105/2-3.9

1.5 Recommended Extras

Options: Modulation Depth Meter SMPU-Z1 240.0326.02
Interface SMPU-Z2 240.3902.02 for connecting
Desk-top Calculator TEK 31 to IEC bus
Navigation SMPU-Z3 240.6018.50
Software SMPU-Z4 240.3948.02 for control from TEK 31

Card Reader PCL 248.6017.07 for entering data and settings
Standard Frequency Receiver XKD 100.5678.03 for crystal frequency checking
Code Converter PCW 244.8015.92 for ASCII-to-BCD code conversion

The PCW is used as a data coupler for adapting parallel remote-controlled instruments to the SMPU data bus, e.g.
Precision LF Generator SSN 204.8014.52 for producing accurate AF signals
Programmable Attenuator Set DPVP 214.8017.52
Decade Signal Generator SMDW (500 MHz) 103.9968.52
Power Signal Generator SMLU (1 GHz) 200.1009.03
} for two- or three-generator measurements

Desk-top Calculator Tektronix TEK 31 for 2048 program steps with options 01, 04, 100
for 5120 program steps with options 01, 07, 100
Distributor for IEC bus 216.0013.02 (24-pin)
Cable for IEC bus 216.0194.02 (24-core, 1 m long)
Cable for IEC bus 216.0207.02 (24-core, 2 m long)

2. Preparation for Use and Operating Instructions

2.1 Legend for Figures 2-1 and 2-2 (see Appendix)

No.	Engraving	Function
1	RF MHz INTERN EXTERN	When indicator INTERN lights up, the frequency of the RF generator incorporated in the SMPU is indicated. When indicator EXTERN lights up, the transmitter frequency of the radio set is indicated.
2	A - dB kHz C - % RESULT MOD. GEN.	When indicator MOD. GEN. lights up, the frequency of the internal AF generator is indicated. When RESULT lights up, the result of the automatic test routine is indicated. If "A" appears in the display, the indication is in dB. If "C" appears, the distortion is indicated in %. If no symbol appears, the result is in kHz with a resolution of 1 Hz.
3	MODULATION V kHz % RAD	The lighting up of the different indicators means: V = indication of level of internal AF generator; kHz = indication of frequency deviation; % = indication of modulation depth; RAD = indication of phase deviation of internal RF generator. The indication is automatically switched over when buttons 36 are pressed.
4	RF LEVEL dB	Indication of RF generator level in $-dBV_{EMF}$
5	VAR	Buttons for enabling variation by means of 27 . The AF generator frequency (lefthand button), AF generator level or modulation (centre button) or RF generator level (righthand button) can be varied.
6	AF LEVEL 3/10/30/100/300 mV 1/3/10 V	Adjustment of measurement range on meter 14 for AF level measurement.
7		Power indication of radio set.
8	POWER	Pilot lamp for RF generator.
9	0.25/2.5/25 W or 0.5/5/50 W	Indication of measurement range of meter 7 ; the range is automatically selected.
10	DISTORTION 1 kHz OFF 300 Hz	Switching on distortion meter at test frequency of 300 Hz or 1 kHz. Indication on readout 2 ; C appears as the last digit. Button OFF is used for stopping the measurement.
11	FILTER CCITT	Weighting of AF measurements by CCITT filter; exception: measurement of wanted modulation.

No.	Engraving		Function
12	X 0.01		Increase in sensitivity of modulation meter 14 by 40 dB for measuring spurious modulation.
13	MODULATION 5 kHz/2 rad/50% 20 kHz/5 rad/100%		Adjustment of measurement range on meter 14 for modulation measurement. The indication mode is selected with 36 .
14			For transmitter tests, indication of modulation meter reading; range selection by means of 13 . For receiver tests, indication of AF level meter reading; range selection by means of 6 .
15	VAR 100 kHz VAR 1 kHz VAR 10 Hz		Buttons for step-wise switching of carrier frequency. Button 25 enables variation in steps of 10 Hz, 1 kHz or 100 kHz.
16	FREQ.	RF MHz	Storing of RF generator frequency in MHz, max. 3 digits before and 5 digits after decimal point.
		AF kHz	Storing of AF generator frequency in kHz. Entry with floating point and a resolution of max. 3 digits; lower frequency limit 10 Hz, upper frequency limit 99.9 kHz.
17	MODULATION	FM kHz	Storing of frequency deviation in kHz, max. 2 digits before and 1 digit after decimal point.
		φM RAD	Storing of phase deviation in rad, max. 2 digits before and 1 digit after decimal point.
		AM %	Storing of modulation depth in %; max. 2 digits before and no digit after decimal point.
18	LEVEL	AF V	Storing of AF generator level in V; max. 1 digit before and 2 digits after decimal point.
		RF dB	Storing of RF level in dBV; max. 3 digits before and no digit after decimal point.
19	ALARM		Indication of faulty operation of modulation depth meter or RF generator.
20	OVERFLOW		The lamp indicates that too many digits before or after the decimal point have been entered. It also lights up if levels below -141 dBV, frequencies above 500 MHz and AF generator frequencies below 10 Hz are adjusted. In these cases, use button CLEAR 24 to cancel inadmissible values and enter correct data.
21	STORE δf kHz		Storing of a frequency δf in kHz, max. 5 digits before and 2 digits after decimal point. See also 23 .
22	0 . 1 2 3 4 5 6 7 8 9		Keyboard for data entry. The data is first stored temporarily and then put into the final store by means of buttons 16 , 17 , 18 , 21 . If more than 8 numbers are entered into the intermediate store, OVERFLOW lamp 20 lights up. The data entry is cleared with button 24 .

No.	Engraving	Function
23	δ f + -	Increase (+) or decrease (-) of RF generator frequency by δ f stored with the aid of button 21 .
24	CL	CLEAR button for - clearing data entered with 22 - extinguishing OVERFLOW lamp if figures with too many places had been entered - interrupting automatic test routines and thus extinguishing BUSY lamp - resetting the SMPU to a defined initial state after the set has been switched on.
25	VARIATION	Knob for varying data entered with 22 . The data to be varied is selected with button 5 or 15 .
26	MOD. AF 	AF output for checking value indicated on meter 14 .
27	AM 	Input for external signal for amplitude modulation. Indication of modulation depth on 3 valid only for constant level of 1 V_{rms}.
28	FM 	Input for external signal for frequency modulation. Indication of frequency deviation on 3 valid only for constant level of 1 V_{rms}.
29	PROGR. COMB. MAN.	In the position PROGR. all front panel controls are blocked; the set functions in the programmed mode only. Programming is not possible in the position MAN. In the position COMB., both programming and manual control are possible at the same time.
30	AM EXT.	When the button is pressed, external amplitude modulation is possible via socket 27 . The internal AM is disabled.
31	FM EXT.	When this button is pressed, external frequency modulation is possible via socket 28 . The internal FM is disabled.
32	FM DC	When this button is depressed, external frequency modulation with DC coupling is possible via socket 28 ; the synchronization of the carrier centre frequency is thus disabled.
33	OFF	Button for resetting 30 , 31 , 32 and 34 and thus for setting the normal state of modulation: AM and FM by means of internal generator, carrier centre frequency synchronized, and electronic attenuation standard disabled.

No.	Engraving	Function
34	VAR. DC	When this button is pressed, the amplitude modulator is used as an electronic attenuation standard. The RF level indicated in -dBV on 4 can be varied in 1-% steps in the range 0 to 100%; the set % value is indicated on 3 . The RF generator output level is equal to the dB value indicated on 4 multiplied by the % value indicated on 3 .
35	BUSY	The lamp lights up if a test routine is being executed or the SMPU is not ready. The measured values are valid only when the BUSY lamp goes out. As long as the BUSY lamp is on, all pushbuttons - except for CLEAR button 24 - are locked. The red CLEAR button causes the BUSY lamp to go out in any case.
36	MOD. MEAS. FM φM AM	Type of modulation indicated on 3 ; the frequency or phase deviation and the modulation depth can be measured.
37	MODULATION INT. FM φM AM	Type of modulation used for RF generator; the RF generator can be frequency-, phase or amplitude-modulated.
	CLEAR	The selected and stored type of modulation is cleared.
38	MOD. GENERATOR INT.	Modulation of device under test (DUT) by means of AF generator incorporated in the SMPU.
	EXT.	Modulation of the DUT by means of the call signal generator incorporated in the radio set; indication of call signal frequency on 2 .
	OFF	DUT not modulated; indication of spurious modulation on meter 14 .
39	ANALYS.	Operation with analyzer. The RF generator signal is available at output RF 2 74 for application to a selective receiver.
40	MOD. INDIC. -	Switchover from positive to negative peak deviation indication.
41	CHECK	Basic adjustment for SMPU self-testing.
42	MODULATION	The modulation is switched on and off by pressing the button repeatedly.
43	RF LEVEL	The level of the RF generator is switched on and off by pressing the button repeatedly.
44	OFF	Reestablishment of the normal state after termination of an automatic test routine and switching off the S/N measurement.
45	SN	Measurement of S/N or SINAD ratio (selected with 51) at any RF level desired. The measurement is continuously performed and can be stopped only with 44 .

No.	Engraving	Function
46	↑ SQUELCH ↓	Measurement of the upper (↑) and the lower (↓) squelch response. The test result is the sum of the levels indicated on 2 and 4 .
47	POWER	Power switch
48	RF →○ R_i 50 Ω	RF input for frequency counter and frequency deviation meter. The input has no overload protection.
49	RF R_i 50 Ω	RF input and RF output for direct connection of radio set. Permissible loading 25 (50) W.
50	○→ ANALYS.	Output for connecting a wave analyzer when button 39 is pressed.
51	SN SINAD	Switchover from S/N to SINAD ratio measurement for test routines selected with 45 and 54 .
52	AF →○ R_i 10 kΩ	AF input for level meter frequency counter and distortion meter
53	AF ○→ R_a 50 Ω	Output of AF generator.
54	SENSITIVITY 20 dB 12 dB	Measurement of sensitivity with an S/N or SINAD ratio (selected with 51) of 20 dB or 12 dB. Indication on 4 .
55	BANDWIDTH + -	Measurement of frequency difference between positive (+) or negative (-) 6-dB point and centre frequency; indication on 2 .
56	DUPLEX	Basic adjustment for duplexer test: Same as for receiver test; however, RF level reduced by 20 dB and RF power meter connected.
57	RECEIVER	Basic adjustment for receiver test: indication of AF level on meter 14 .
58	XMITTER	Basic adjustment for transmitter test: indication of carrier power on 7 , carrier frequency on 1 and modulation on 14 .
59	POWER	Power cable for RF generator.
60		Voltage selector with power fuse for RF generator.
61		50-core control cable.
62		24-core control cable

No.	Engraving	Function
63	○← 10 MHz	10-MHz control frequency input for RF generator and frequency counter.
64	→○ 10 MHz CONTROL FREQ.	Output of 10-MHz crystal oscillator.
65	RF	RF generator output with a constant level of 1.2 V.
66	ALC	Input of RF ALC circuit.
67	30 MHz	30-MHz input; can be modulated.
68	CONTROL FREQ. ADJ.	Adjustment of 10-MHz crystal oscillator.
69	30 MHz	30-MHz output; not modulated.
70	10 MHz	10-MHz output for counter.
71	30 MHz	30-MHz modulator output.
72	30 MHz	30-MHz modulator input; not modulated.
73	10 MHz	10-MHz input for counter.
74	RF 2	Second output of RF generator when using an analyzer (button 39 pressed).
75	ADC	Input of A/D converter for DC voltage measurement.
76	CONTR.	Output of control relays for DUT.
77	DATA I/O	Connector for programming and data output.
78	ALC	Output for control voltage of RF ALC circuit.
79	RF	Input for RF attenuation standard.
80		Voltage selector with power fuse for complete set excluding RF generator.
81	POWER	Power connector
82	POWER	Power output for connection of RF generator.
83	INDICATOR	Connector for 50-core control cable.
84	INDICATOR	Connector for 24-core control cable.

2.2 Preparation for Use

2.2.1 Setting Up the Test Assembly

Fig. 2-2 (see Appendix) shows how the two SMPU units are connected with the aid of cables.

2.2.2 Adjusting to the Local AC Supply Voltage

The SMPU has been designed in compliance with the safety regulations according to VDE 0411 Class I. Class I requires insulation of the AC supply during operation. In addition, all exposed conducting elements that are likely to be immediately alive in the case of a failure must be properly and permanently connected with each other and with the non-fused earthed conductor. The power plug should therefore be inserted only into an earthing contact type socket.

> The SMPU consists of two units, each having a separate voltage selector. It is absolutely necessary to check both selectors and, if required, to adjust them to the correct voltage.

The SMPU units are factory-adjusted for operation from 220 V AC. After adjusting the two selectors 60 and 80 , the SMPU can be operated also from a 115-V, 125-V or 235-V AC supply. For this purpose, unscrew the fuses from 60 and 80 and remove the cover of the voltage selector. Introduce the cover again such that the marker line points to the desired AC supply voltage. Then screw in the fuse required, i.e.:

M 2 C (DIN 41571) for 115 or 125 V
M 1 C (DIN 41571) for 220 or 235 V.

The SMPU is connected to the AC supply via socket 81 using the power cable supplied with the set.

AC supply fluctuations up to ±10% from nominal do not affect the specifications listed under 1.3. Greater fluctuations should be avoided and a transformer or stabilizer connected ahead of the SMPU.

2.2.3 Adjusting the Mechanical Zero of the Meters

Prior to switching the set on, check whether the pointers of meters 7 and 14 are at zero. The position can be corrected with the aid of the slotted-head screws located below the meters.

2.2.4 Switching On

After pressing the green button POWER 47 , the SMPU is ready for operation. A warmup of max. 5 minutes is required until the characteristics specified under 1.3 are obtained. The crystal warmup time is max. 15 minutes for full frequency accuracy.

2.2.5 Changing the Power Measurement Range

The SMPU can be used with the power measurement range 0.25/2.5/25 W or 0.5/5/50 W. To obtain the range 0.5/5/50 W, an additional 3-dB attenuator is connected between the RF input 49 and the power meter. The attenuator is incorporated in the SMPU and has only to be inserted between cables K32 and K35. The label associated with the indication 9 shows the power ranges and should be exchanged if the measurement range is changed.

2.2.6 Connecting the Radio Set

During all measurements, the antenna input/output of the radio set is connected to socket RF 49 which accepts a power of up to 25 W or 50 W (see section 2.2.5). The AF output of the radio set is connected to socket AF 52 and its modulation input to socket AF 53 .

Different functions of the radio set can be automatically controlled from the SMPU. The contacts of the control relays are brought out at the rear socket CONTR. 76 . For the contact occupation see Table 2-1 of Appendix.

2.3 Operating Instructions

Section 2.3 describes the adjustments required for manual operation of the SMPU. Manual operation is possible only if switch 29 is set to MAN. or COMB.

2.3.1 Basic Adjustment

After switching on the SMPU, the following basic adjustments are required:

- Press the red CLEAR button 24 . In this way, the microcomputer incorporated in the SMPU is brought to a defined initial state. After the CLEAR button has been pressed, the BUSY button should go out in any case.
- Press OFF button 33 . In this way, the modulation is set to its normal condition, i.e. modulation by the internal generator and synchronization of the carrier centre frequency in the case of FM.
- Press buttons FREQ. RF 16 and LEVEL RF 18 . In this way, the carrier frequency and the level are set to zero. The OVERFLOW lamp should go out.

Now the SMPU is ready for operation and the desired mode can be selected. For data entry see section 2.3.8.

2.3.2 Transmitter Measurements

The SMPU is adjusted for transmitter measurements by pressing button XMITTER 58 which sets all functions and relay boards accordingly. The transmitter power of the radio set is directly applied to socket 49 of the SMPU.

2.3.2.1 Measurement of Transmitter Power

After pressing button XMITTER 58 , the transmitter power is directly indicated on meter 7 . The range of the power meter is automatically selected and indicated by

lamps 9 . Switchover between the ranges 0.25/2.5/25 W and 0.5/5/50 W is possible (see section 2.2.5).

Note: To ensure that the RF power measurement remains within the guaranteed error limits, terminate output ANALYS. 50 with 50 Ω.

2.3.2.2 Measurement of Transmitter Frequency

After pressing button XMITTER 58 the transmit frequency of the radio set is indicated on the digital readout 1 . The word EXTERN lights up. The frequency is indicated with a resolution of 10 Hz. The measuring time is 0.8 sec for frequencies above about 10 MHz and 0.1 sec for frequencies below about 10 MHz.

Note: If the AF frequency counter is connected at the same time, the gate time is 1 sec longer.

2.3.2.3 Measurement of Modulation

After pressing button XMITTER 58 , meter 14 indicates the modulation of the radio set. The mode of indication (frequency or phase deviation, modulation depth) is selected with buttons MOD. MEAS. 36 . The selected mode remains stored until it is replaced by a new adjustment. Thus it need not be entered anew for each transmitter test.

The modulation meter is fully automatic. No frequency adjustment is required. ALARM lamp 19 goes out when the modulation meter is correctly set.

Two measurement ranges are available which are selected with buttons 13 . With the corresponding button (FM, φM, AM) in row 36 pressed, 5 kHz or 20 kHz can be selected for the frequency deviation, 2 rad or 5 rad for the phase deviation and 30% or 100% for the modulation depth.

2.3.2.4 Operation of AF Generator

The AF generator incorporated in the SMPU is used for modulation of the radio set. It is switched in by pressing button MOD. GENERATOR INT. 38 . Button INT. 38 is automatically actuated when button XMITTER 58 is pressed. The AF generator output voltage is available at AF output 53 . The frequency and level are entered from keyboard 22 and stored with buttons AF 16 and AF 18 . The level of the AF generator is indicated on the digital readout 3 . The frequency is displayed on 2 when indicator MOD. GEN. lights up.

2.3.2.5 Measurement of Call Signal and Call Signal Frequency Deviation

When button MOD. GENERATOR EXT. 38 is pressed, the AF generator incorporated in the SMPU is disconnected. At the same time the AF frequency counter of the SMPU is connected to digital readout 2 . When indicator RESULT lights up, the call signal frequency of the radio set is indicated on 2 . The resolution is 1 Hz. If the RF frequency counter is also connected, the gate time is 1.1 sec for frequencies below 60 MHz and 1.8 sec for frequencies above 60 MHz. Meter 14 indicates the frequency deviation of the call signal.

The call signal generator in the radio set can be automatically switched on from the SMPU. For this purpose, a control relay is connected to control socket 76 of the SMPU when button EXT. 38 is pressed. For the contact occupation of the control socket see Table 2-1 of Appendix.

2.3.2.6 Measurement of Spurious Modulation

When button MOD. GENERATOR OFF 38 is pressed, the AF generator of the SMPU and the call signal generator of the radio set are disconnected. Thus the radio set receives no modulation voltage. At the same time, the sensitivity of the modulation meter is increased by a factor of 100. To indicate this, button X 0,01 12 and the red pilot lamp of meter 14 light up. The spurious deviation of the radio set can be directly read on meter 14 . The increased sensitivity is effective for both measurement ranges which are selected with 13 . Thus the ranges are 50 Hz and 200 Hz for frequency deviation, 0.02 and 0.05 rad for phase deviation and 0.3 and 1% for modulation depth.

Button X 0,01 can also be used for switching the corresponding measurement range.

2.3.2.7 Weighting of Modulation Indication

With button X 0.01 12 released, the positive peak value of the wanted modulation is indicated for all three types of modulation. When button -MOD INDIC. 40 is pressed, the negative peak value is indicated. When actuating the button again, the meter is switched over to positive peak value indication.

With button X 0,01 12 lighting up, the rms value of the spurious modulation is indicated. The spurious modulation can be measured either with a bandwidth of about 50 Hz to 20 kHz or weighted with the aid of a CCITT filter. The weighting filter is switched in by pressing button FILTER 11 and switched off by pressing this button a second time.

Note: The wanted modulation can be measured only in the unweighted mode. For this reason, button FILTER 11 cannot be pressed when the SMPU is set for measuring the wanted modulation.

2.3.2.8 Measurement of Modulation Distortion

The modulation distortion can be measured at the modulation frequencies of 1 kHz and 300 Hz. When pressing button DISTORTION 1 kHz or 300 kHz 10 , the digital distortion meter is switched in. The test result appears on the digital readout 2 ; in this case, the indicator RESULT lights up and the letter C appears in the last place of the display. The distortion meter has the measurement range of 0.2 to 99%. The measured values are indicated with a resolution of 0.1%. After automatic range selection about two measurements per second are performed. For each test cycle, button 1 kHz or 300 Hz 10 lights up once.

Prior to switching in the distortion meter, make sure that the following points are observed:

- The frequency of the AF generator should be exactly 1 kHz or 300 Hz. Otherwise erroneous measurements will be obtained.
- The modulation signal to be measured must not overdrive the modulation meter 14 . Otherwise the distortion meter will show no indication.

The distortion meter is switched off by pressing button DISTORTION OFF.

2.3.2.9 Analyzer

After pressing button ANALYS. 39 , the transmit signal of the radio set is available at socket ANALYS. 50 with a 26-dB attenuation. Here an analyzer can be connected for examining the signal spectrum.

When button ANALYS. 39 is pressed, the output signal of the RF generator incorporated in the SMPU is applied to socket RF 2 74 on the rear of the set. When adjusting the frequency and level accordingly, an RF signal of 100 kHz to 500 MHz with a level of 1 V_{EMF} is available. Thus the SMPU can be used as a heterodyning oscillator for a selective receiver. It is best to use the Programmable Receiver/Demodulator USPU for this purpose.

2.3.3 Receiver Measurements

The SMPU is set for receiver measurements by pressing button RECEIVER 57 . In this mode, the RF generator of the SMPU is taken to socket 49 and thus to the antenna input of the radio set. The internal modulation is switched in. Moreover, the AF level meter of the SMPU is connected to the AF output of the radio set via socket 52 so that the AF voltage of the DUT can be read directly.

2.3.3.1 Frequency Adjustment

The frequency of the RF generator is entered from keyboard 22 and stored with button RF 16 . The frequency is displayed on the digital readout 1 , indicator INTERN lighting up. The resolution is 10 Hz. The entered frequency is stored in the set and can be called as often as required by pressing button RECEIVER 57 .

The carrier frequency can be changed by

- a new frequency entry from keyboard 22
- continuous variation with knob 25 (see section 2.3.9)
- stepwise variation with buttons $\pm\delta f$ 23 (see section 2.3.10).

2.3.3.2 Level Adjustment

The level of the RF generator is switched in by pressing button RF LEVEL 43 and switched off by pressing this button again. The level is entered from keyboard 22 , stored with button RF 18 and indicated on the digital readout 4 . The indication is in dB, referred to 1 V_{EMF}. The level range is -141 to 0 dBV.

Fine Adjustment in Percent

The above described adjustment permits the level to be set with a resolution of 1 dB. Fine adjustment is possible by pressing button VAR DC 34 . Now the AM modulator is used as an additional electronic attenuation standard; the control is the same as when setting the SMPU for amplitude modulation. The adjusted level is obtained when multiplying the level value read on 4 by the percentage given on 3 .

Example: -120 dBV are displayed on 4 and 95% on 3 . The RF output level is -120 dBV reduced by 5%, i.e. about -126.5 dBV.

Amplitude Modulation with Switched in Electronic Level Variation

In this case the readout for the modulation depth displays the level varied in percent. Therefore, the frequency deviation adjustment must be used for adjusting the amplitude modulation. With button VAR DC 34 pressed and the AM mode switched in, the adjustment of 22.0 kHz, for instance, means a modulation depth of 22%. In the FM mode, however, the kHz display indicates the normal frequency deviation.
In this mode, frequency and amplitude modulation are not possible at the same time.

2.3.3.3 Modulation of RF Generator

The SMPU can be frequency-, phase- and amplitude-modulated. Amplitude and frequency modulation or amplitude and phase modulation are possible at the same time while frequency and phase modulation cannot be performed simultaneously. The type of modulation is selected with buttons MODULATION INT. 37 . The selected mode is stored in the SMPU so that it has to be entered only once. Switchover to a different type of modulation is possible by pressing button CLEAR 37 and selecting the required mode. Button CLEAR erases the modulation mode store but is not intended for switching in and off the modulation. Button MODULATION 42 is used to switch the selected modulation mode in and off.

The modulation values are entered from keyboard 22 , stored with buttons 17 and indicated on readout 3 . The frequency deviation can be set from 0.1 Hz to 99.9 kHz with a resolution of 10 Hz and the modulation depth from 1% to 99% with a resolution of 1%. The phase deviation can be adjusted from 0.1 rad to 99.9 rad; however, this range can be used only up to about 10 rad.

The digital readout 3 automatically switches over to the selected type of modulation. If two modes of modulation are selected at the same time, the modulation depth is indicated (for AM). Switchover of the readout is possible by pressing the corresponding button FM, φM, AM 37 . The value associated with the last button pressed is indicated.

2.3.3.4 External Modulation Inputs

In general, the built-in AF generator is used for modulating the SMPU. However, an external AF generator can be connected to sockets AM 27 and FM 28 . When pressing button AM EXT. 30 or FM EXT. 31 , the corresponding input is connected and the internal AF generator disconnected.

Note: The digital readout 3 indicates the modulation values within the guaranteed error limits only if the voltage of 1 V_{rms} is present at socket AM 27 or FM 28 .

Input FM 28 is AC-coupled with a lower cutoff frequency of about 20 Hz. With AC coupling, the carrier centre frequency of the SMPU is synchronized even in the FM mode. When pressing button FM DC 32 , input FM 28 is switched over to DC coupling. In this case, the synchronization of the carrier centre frequency is disabled. Thus the lower cutoff frequency (FM) is not limited so that input FM 28 can be used also for narrowband sweeping and frequency tuning.

Button OFF 33 is the clear button for 30 , 31 , 32 and 34 .

2.3.3.5 Measurement of AF Level

When pressing button RECEIVER 57 or DUPLEX 56 , the AF level meter is automatically switched in. Meter 14 indicates the level of the AF signal applied to socket 52 .

The measurement range is selected with the keys AF LEVEL 6 . The ranges are switched in steps of 10 dB. The measurement range of the level meter is automatically selected for automatic test routines. In manual operation, automatic range selection is possible by switching in the distortion meter for a short moment with buttons 10 .

The AF level meter measures rms values. When the CCITT filter is connected into circuit with button FILTER 11 , CCITT-weighted measurement of the AF signal is possible.

The undetected signal of the AF level meter is available at socket MOD. AF 26 for monitoring purposes.

2.3.3.6 Measurement of AF Distortion

The AF distortion is measured in the same way as the modulation distortion (see section 2.3.2.8). Make sure that the frequency of the modulation generator is set exactly to 1 kHz or 300 Hz. Otherwise erroneous measurements will result.

Measurement of the AF distortion is possible with or without CCITT filter. To avoid incorrect measurements, first check whether button 11 is engaged.

Note: In addition to the harmonics of the fundamental, the distortion meter responds to broadband noise. For this reason, distortion measurement should be made at a sufficiently high signal-to-noise ratio. Otherwise too high distortion values will be obtained.

2.3.4 Duplexer Measurements

When button DUPLEX 56 is pressed, the useful signal transfer can be measured. The SMPU is set in the same way for duplexer as for receiver measurements (see section 2.3.3) except for the following:

- Like for transmitter measurements, the RF input 49 is taken to a 20-dB attenuator so that the transmitter power of the radio set can be directly applied.
- The RF power meter 7 is switched in.

- The RF level of the SMPU is attenuated by 20 dB due to the inserted attenuator. Thus the level at socket 49 is 20 dB lower than the level displayed on the readout 4 .

In the DUPLEX mode, all measurements, including the automatic test routines, can be carried out in the same way as in the RECEIVER mode. Note only that the level meter indication has to be reduced by 20 dB.

2.3.5 Measurement of DC Voltages

Socket ADC 75 on the rear of the SMPU is directly connected to the input of the analog/digital converter incorporated in the SMPU. A DC voltage which is applied to this socket is not displayed on the SMPU Indicator but made available at the data output in programmed operation (see section 2.4.4.4).

The input handles levels in the range 0 to +5 V. It can be used for connecting the analog outputs of additional measuring instruments to the IEC bus. Thus no IEC-compatible data coupler is required. For instance, an ammeter or a programmable receiver, e.g. the USPU, can be connected in this way.

2.3.6 Automatic Test Routines

The test routines stored in the SMPU are started by pressing the corresponding program button AUTOMATIC TEST 45 , 46 , 54 or 55 . Fully automatic execution of the program is ensured. While the test routine is running through, the red BUSY lamp 35 is constantly on; at the end of the program, the lamp goes out. The test result is valid after the BUSY lamp has gone out.

When button OFF 44 is pressed, the normal operating condition is reestablished. The OFF button can be actuated only after the BUSY lamp has gone out.

A test routine can be interrupted at any time during execution. For this purpose, press the red CLEAR button 24 .

2.3.6.1 Measurement of 6-dB Receiver Bandwidth

Prior to starting the program, enter the nominal centre frequency of the receiver from keyboard 22 and store this value with button RF 16 . The other settings are made automatically.

The test routine is started by pressing button BANDWIDTH + 55 (positive frequency difference) or BANDWIDTH - 55 (negative frequency difference). First the RF level is determined for a noise decrease of 10 dB, next the RF level is increased by 6 dB and the carrier frequency varied in the positive or negative direction until the same noise value is reached. The difference between this frequency and the previously entered centre frequency is displayed in kHz on the readout 1 ; in this case, the word RESULT appears.

Note: The entered carrier centre frequency remains stored in the SMPU. Thus no new entry of the carrier centre frequency is required if the bandwidth program is executed several times. The carrier centre frequency can also be recalled by pressing button OFF 44 or RECEIVER 57 .

2.3.6.2 Measurement of Receiver Sensitivity

The test routine is started by pressing button SENSITIVITY 20 dB 54 or SENSITIVITY 12 dB 54 . The program determines the RF level at which the S/N ratio at the AF output of the radio set is 20 dB or 12 dB. Two methods can be used: either the measurement of the S/N ratio for which the signal is compared with and without modulation or the measurement of the SINAD ratio for which the fundamental of the modulation is filtered off in a 1-kHz bandstop filter. Make sure in the latter case that the modulation frequency is accurately set to 1 kHz. Otherwise incorrect measurements might result. Changeover from one method to the other is possible with switch SN/SINAD 51 .

The result of the sensitivity measurement is indicated in dBV (RF level) on the readout 4 .

2.3.6.3 Measurement of Squelch Response

The upper squelch response level is measured when button SQUELCH ↑ 46 is pressed and the lower squelch response level is determined by actuating button SQUELCH ↓ 46 . For accurate determination of the response levels, the AM modulator is used as an additional attenuation standard with a resolution of 0.1 dB. For this reason, the result of the squelch response measurement is the sum of two attenuation values. When one of the two SQUELCH buttons is pressed, the measured level is equal to the sum of the values displayed on 4 and 2 . The word RESULT lights up on 2 . In addition, the letter A lights up at the end of the readout, meaning that the indication is in dB.

Example: Readout 4 displays 122 and readout 2 displays 02.60 A. Thus the squelch response is at -124.6 dBV.

The squelch response is measured with the modulation switched in. In the FM mode, the modulation is adjusted in the normal way. In the case of AM, the modulation is entered with the FM button. A deviation of 1 kHz corresponds to 1% modulation depth. See also section 2.3.3.2.

2.3.6.4 Measurement of S/N Ratio

When button SN 45 is pressed, the S/N ratio of the AF signal applied to socket 52 is measured in fully automatic operation. Depending on the position of switch 51 , the S/N ratio or the SINAD ratio is measured. The test result appears in dB on readout 2 and the word RESULT lights up. The physical unit is dB since the letter A lights up.

In contrast to the remaining test routines, the S/N ratio measurement is executed not once but continuously about twice a second. The measurement is stopped by pressing button OFF 44 .

Note: In the SINAD mode, the modulation frequency must be accurately set to 1 kHz. Otherwise incorrect measurements might result.

2.3.7 Self-testing Facility

Connect AF output 53 via a BNC cable to AF input 52 . After pressing button CHECK 41 , the functions of the SMPU can be tested without additional instruments. With both the CHECK and the RECEIVER mode switched in, each generator of the SMPU is compared with an SMPU indicator. If the values coincide within the specified tolerances, it is most probable that generator and indicator operate properly. If the permissible tolerances are exceeded, it has to be determined whether the generator or the indicator section is defective. In this way, the following functions can be checked.

Frequency of AF Generator

The frequencies entered from keyboard 22 are checked on the digital readout 2 . Note that the AF counter functions correctly only if the AF level meter 14 is driven up to one third of full level. To this effect, the AF generator level and the level measurement range have to be selected correctly.

Level of AF Generator

The level of the AF generator entered from keyboard 22 is checked with the aid of the AF level meter 14 .

Distortion of AF Generator

The distortion of the AF generator is checked after switching in the AF distortion meter with one of buttons 10 . Make sure that the frequency of the AF generator is accurately set to 1 kHz or 300 Hz. Otherwise erroneous measurements might be obtained.

Carrier Frequency and Frequency Counter

The carrier frequency which is entered from keyboard 22 is checked on readout 1 . The measurement is made with both the CHECK and the DUPLEX mode switched in. The carrier level is 0 dBV.

Frequency Modulation and FM Meter

This test is not made in the CHECK mode but in the XMITTER mode (button 58 pressed). The modulation is switched in with button 42 . No signal should be applied to sockets 48 and 49 ; readout 1 should thus display zero. The modulation entered from keyboard 22 can now be checked on modulation meter 14 .

FM Modulation Distortion

The settings are the same as for checking the frequency modulation. In addition, the distortion meter is switched in with one of buttons 10 .

Make sure that the modulation frequency is accurately set to 1 kHz or 300 Hz. The modulation distortion is displayed on readout 2 .

2.3.8 Data Entry

All settings of the SMPU are entered from keyboard 22 . The data is first applied to an intermediate register and then stored by pressing the corresponding button 16 , 17, 18 .

The values can be entered only in those units marked on the keys. Note that the number of digits before the decimal point should not exceed the permissible format. If too many digits have been entered before the decimal point, the OVERFLOW lamp 20 lights up. The CLEAR button 24 extinguishes the OVERFLOW lamp. If the CLEAR button is pressed, the intermediate register is erased at the same time so that the information which is not yet finally stored is cancelled. The number of digits after the decimal point is also limited. However, if this limit is exceeded, the OVERFLOW lamp does not light up and the excessive digits are lost.

The following data can be entered:

Carrier frequency: Button FREQ. RF 16 , entry in MHz, max. 3 digits before and 5 digits after the decimal point.

Modulation frequency or AF generator frequency: Button FREQ. AF 16 , entry in kHz with floating point, max. 3 digits, 2 digits before the decimal point. Note that the lower frequency limit of the AF generator is 10 Hz; frequencies below 10 Hz cause the OVERFLOW lamp to light up.

Frequency deviation: Button MODULATION FM 17 , entry in kHz, max. 2 digits before and 1 digit after the decimal point.

Phase deviation: Button MODULATION φM 17 , entry in rad, max. 2 digits before and 1 digit after the decimal point.

Modulation depth: Button MODULATION AM 17 , entry in %, max. 2 digits before and no digit after the decimal point.

Level of AF generator: Button LEVEL AF 18 , entry in V, max. 1 digit before and 2 digits after the decimal point.

Level of RF generator: Button LEVEL RF 18 , entry in dBV, max. 3 digits before and no digit after the decimal point. If attenuation values above 141 dB are entered, the OVERFLOW lamp lights up.
Pressing one of buttons 16 , 17 , 18 automatically erases the intermediate store. Pressing one of these buttons a second time enters zero into the corresponding store. If, however, button FREQ. AF 16 is pressed for the AF generator frequency, this causes the OVERFLOW lamp to light up since a frequency below 10 Hz is not permissible.

Normally the settings entered are displayed on the corresponding readout so that they can be checked easily. The values are stored even if the readout is not in operation, for instance with the RF level or the modulation switched off. The stored data entries are maintained in the SMPU until they are overlaid by other values.

2.3.9 Variation of Setting Data

All settings entered from keyboard 22 can be varied with knob 25 . For this purpose, the rotary knob has to be addressed for the quantity to be varied using buttons VAR 5 and 15 . Pressing a new VAR button clears the button pressed before.

The carrier frequency can be varied in 10-Hz steps with button VAR 10 Hz 15 , in 1-kHz steps with button VAR 1 kHz 15 and in 100-kHz steps with button VAR 100 kHz 15 .

The AF generator frequency can be varied after pressing the lefthand button VAR 5 . The third place of the set frequency value is varied in floating point format.

The AF generator level or the modulation can be varied after pressing the centre button VAR 5 . The quantity displayed is varied in this case.

The RF generator level can be varied after pressing the righthand button VAR 5 .

Turning knob 25 varies the displayed data and the values stored in the SMPU. Thus the stored information is replaced by the new values set during variation.

2.3.10 Frequency Variation in Optional Steps

Pressing button +δf 23 or -δf 23 varies the carrier frequency as often as required in steps of δf. After entry from keyboard 22 , the selected δf step is stored by pressing button STORE δf 21 . The δf step is entered in kHz with max. 6 digits before and 2 digits after the decimal point.

This facility can be used for instance for frequency switching at the channel spacing.

2.4 Programming

Switch 29 permits selection of manual, programmed or combined operation.

Manual mode: Switch 29 is set to MAN. In this mode, the SMPU can be operated only by hand. Programming is inhibited.

Programmed mode: Switch 29 is set to PROGR. In this mode, programming is possible. Manual operation is excluded; all data entry keys are blocked. However, execution of the individual programming commands can be checked on the readouts and with the aid of the pilot lamps incorporated in the keys. This mode is especially suitable for fully automatic operation since interventions in the test routine are not possible.

Combined mode: Switch 29 is set to COMB. In this mode, manual operation and programming are possible at the same time. Commands entered by hand can be overlaid by programming and vice versa. Execution of the programming commands can also be checked on the readouts and with the aid of the illuminated keys. This mode is especially suitable for semi-automatic operation. It offers simple programming aids to the operator.

In addition, the combined mode is very useful for setting up test routines for fully automatic systems.

2.4.1 General

All input/output commands and data are coded in 7-bit ASCII (see Table 2-3 of Appendix). All characters used are printable symbols and can be generated and processed in normal data systems.

A single data connector is used for programming of the SMPU and for its data output. Data and instructions are entered as coded characters in serial form. The SMPU delivers

the measured values in the same form on the data connector. The data connector 77 is located on the rear of the SMPU. It is designed in accordance with the IEC standard for programmable measuring instruments. In this way it is ensured that the SMPU can be programmed by standard equipment and used in combination with other measuring instruments.

If equipment which is compatible with the IEC bus is used for programming and data processing, detailed knowledge of the functioning of data bus and interface is not required. It is sufficient to know the programming instructions and data output formats which are explained below.

2.4.2 Addressing

See Table 2-4 (Appendix)

To permit the combination of several instruments and to enable the distinction between listener and talker, each instrument has to be provided with an address. Like the rest of the information, the address is transmitted in the form of an ASCII character.

The SMPU is suitable for both data receiving and sending. For this reason, it has a send and a receive address. The addresses can be set on the data coupler board with switch S1 in accordance with Table 2-4. The SMPU is factory-adjusted to the receive address / and the send address 0. The erase commands for both addresses are fixed according to the IEC standard and cannot be altered. The receive address is cancelled with the character ? and the send address with the character ⟶. Both addresses can be simultaneously cleared with the aid of the IFC line. After switching on the SMPU, the two addresses have to be reset first with the IFC line. During subsequent programmed operation, setting of the receive address automatically clears the send address and vice versa so that the corresponding reset commands are not required.

The two lamps D1 and D2 on the data coupler board enable monitoring of the address status of the SMPU. The illuminated lamp indicates that the corresponding address has been set.

2.4.3 Programming Hints

See Fig. 2-3 (Appendix)

Programming of the SMPU corresponds to manual operation. Each front-panel key can be remote-controlled by entering a combination of two ASCII characters. Inputting of a number or decimal point requires only one ASCII character. Fig. 2-3 shows how the characters are associated with the individual keys. Thus programming consists of a series of ASCII characters which correspond to the keys to be controlled.

Note that knob 25 can also be remote-controlled. The quantity to be varied is switched by one step if the corresponding command is entered.

Examples:		
	Set receive address of SMPU	/
	Select RECEIVER mode	@ U
	Select FM	G\
	Set carrier frequency to 134.657 MHz	134.657 @ ←
	Set modulation frequency to 1.5 kHz	1.5 I ↑

Set carrier level to 80 dB	80 B←
Adjust for positive 6-dB measurement	F T
Clear receive address	?

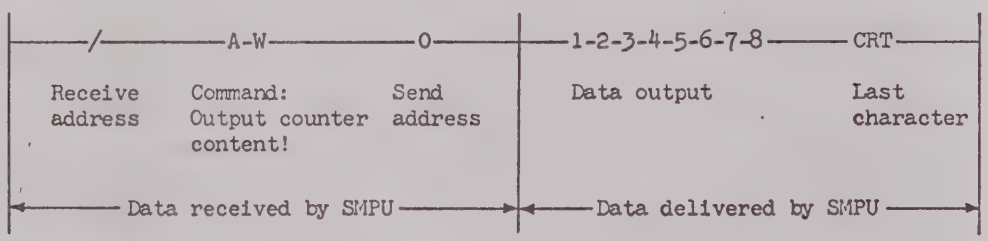
2.4.4 Data Output

The data output of the SMPU is performed as follows:

- ► Set the receive address of the SMPU
- ► Determine the quantity to be delivered by entering the two ASCII characters required (see Table 2-5 and Fig. 2-3).
- ► Set the send address of the SMPU
- ► The desired data is now automatically delivered.
- ► The last character of the delivered data is the command CRT (carriage return).

  Next the send address of the SMPU is reset.

Example: Output of the RF frequency counter reading



2.4.4.1 Output of RF Frequency Counter Reading

Output command:	AW
Output format:	8 digits with subsequent CRT
Example:	12345678CRT means 123.45678 MHz

2.4.4.2 Output of RF Level Meter Reading

Output command:	MX
Output format:	5 digits with subsequent CRT. The first 4 digits represent the deflection of level meter 7 referred to f.s.d. The full-scale deflection of the meter corresponds to the number 1000. The fifth digit represents the measurement range of the level meter: 6 corresponds to the lowest range of 0.25 W or 0.5 W 5 corresponds to the mid-range of 2.5 W or 5 W 3 corresponds to the highest range of 25 W or 50 W
Note:	The RF level is delivered in V. Using the voltage E and the full-scale deflection value P_E, the power P is calculated from the following formula: $P = \left(\frac{E^2}{10^6} + 0.005\right) P_E$

Example: 01236CRT means $(0123^2 \times 10^{-6} + 0.005)$ 0.25 W

2.4.4.3 Output of AF Level Meter and Modulation Meter Readings

The AF level is delivered in the RECEIVER and DUPLEX modes. The reading of the modulation meter is output in the XMITTER mode.

Output command: OX

Output format: 5 digits with subsequent CRT. The first 4 digits represent the deflection of meter 14 , f.s.d. corresponding to the number 1000. The fifth digit represents the measurement range:

0 corresponds to range 3 mV 4 corresponds to range 300 mV
1 corresponds to range 10 mV 5 corresponds to range 1 V
2 corresponds to range 30 mV 6 corresponds to range 3 V
3 corresponds to range 100 mV 7 corresponds to range 10 V

Note: In the XMITTER mode, the modulation meter reading is output; the measurement range is not delivered; thus the fifth digit is not valid.

Examples:

Receiver or duplexer measurement: 04255CRT corresponds to 0.425 V
04251CRT corresponds to 4.25 mV

Transmitter measurement: 04255CRT corresponds to 0.425 times the full-scale deflection of the applicable modulation measurement range, e.g. 0.425 x 20 kHz = 8.5 kHz.

2.4.4.4 Output of DC Voltage Applied to ADC Input

Output command: KX

Output format: 5 digits with subsequent CRT. The first 4 digits represent the level applied to the A/D converter, referred to full scale. If a DC voltage of ~~+5 V~~ 100mV is applied to socket ADC 75 , the A/D converter receives the full signal level and the number 1000 is output. The fifth digit is not valied.

Example: 01003CRT corresponds to 0.5 V at ADC input 75 .

2.4.4.5 Output of Varied Quantity

Output command: O←

This command causes the output of the quantity which has been selected with buttons 5 and 15 . Thus the output quantity and format depend on the button pressed:

Button VAR 10 Hz 15 : Variation of the carrier frequency in 10-Hz steps. Output of the SMPU carrier frequency with a resolution of 10 Hz in the format "8 digits with subsequent CRT". Example: 12345678CRT corresponds to 123.45678 MHz.

Button VAR 1 kHz 15 : Variation of the carrier frequency in 1-kHz steps. Output of the SMPU carrier frequency with a resolution of 1 kHz in the format "6 digits with subsequent CRT". Example: 123456CRT corresponds to 123.456 MHz.

Button VAR 100 kHz 15 : Variation of the carrier frequency in 100-kHz steps. Output of the SMPU carrier frequency with a resolution of 100 kHz in the format "4 digits with subsequent CRT". Example: 1234CRT corresponds to 123.4 MHz.

Lefthand button VAR 5 : Variation of the AF generator frequency. Output of the AF generator frequency with a three-digit resolution in the format "4 digits with subsequent CRT". The last three digits represent the frequency value, the first digit indicates the range of the AF generator:

0 corresponds to frequency range 10 Hz - 100 Hz
1 corresponds to frequency range 100 Hz - 1 kHz
2 corresponds to frequency range 1 kHz - 10 kHz
3 corresponds to frequency range 10 kHz - 100 kHz
Examples: 1234CRT corresponds to 234 Hz.
2234CRT corresponds to 2.34 kHz.

Centre button VAR 5 : Variation of the AF generator level or of the modulation. The last quantity addressed is output.
Output of the AF generator level with a resolution of 10 mV in the format "digits with subsequent CRT".
Output of the frequency deviation with a resolution of 100 Hz in the format "3 digits with subsequent CRT".
Output of the phase deviation with a resolution of 0.1 rad in the format "3 digits with subsequent CRT".
Output of the modulation depth with a resolution of 1% in the format "2 digits with subsequent CRT".

Examples: AF generator level: 123CRT corresponds to 1.23 V
FM: 123CRT corresponds to 12.3 kHz
φM: 123CRT corresponds to 12.3 rad
AM: 12CRT corresponds to 12%.

Righthand button VAR 5 : Variation of the RF generator level. Output of the level with a resolution of 1 dB in the format "3 digits with subsequent CRT".

2.4.4.6 Output of Results for Test Routines

Output command: M←—

With the RESULT indicator lighting up, the last value indicated on readout 2 is delivered. The output is in the format "5 digits with subsequent CRT". The following values can be output:

AF frequency counter reading with a resolution of 1 Hz in the format "5 digits with subsequent CRT".
Example: 12345CRT corresponds to 12.345 kHz.

Distortion meter reading with a resolution of 0.1% in the format "4 digits with subsequent C and CRT". The first three digits indicate the distortion, the fourth digit is not valid.
Example: 123XCCRT corresponds to 12.3%.

S/N ratio with a resolution of 0.1 dB in the format "4 digits with subsequent A and CRT". The first three digits indicate the S/N ratio, the fourth digit is not valid.
Example: 123XACRT corresponds to 12.3 dB.

In the case of squelch measurements: the attenuation of the electronic attenuation standard with a resolution of 0.1 dB in the format "4 digits with subsequent A and CRT". The first three digits indicate the attenuation, the fourth digit is not valid.
Example: 123XACRT corresponds to 12.3 dB.

Note: The result of the bandwidth measurement is displayed on readout 2 when the RESULT indicator lights up. However, this result cannot be read out under this address. The result of the bandwidth measurement is output under the address associated with the output of the RF frequency counter reading (see section 2.4.4.1). The output has a resolution of 10 Hz in the format "8 digits with subsequent CRT".
Example: 00000123CRT corresponds to 1.23 kHz.

2.5 Data Transmission

Knowledge of the technical details described below is not absolutely necessary when using equipment in accordance with the IEC standard. They are, however, of assistance when employing not fully compatible instruments or developing a special interface.

2.5.1 Programming Connector

The SMPU programming and data connector 77 is a 24-way Amphenol socket. For the contact occupation see Table 2-2 (Appendix).

2.5.2 Code

All data and commands are transmitted as 7-bit characters in ASCII; see Table 2-3. Only those characters are used which are available on a normal teleprinter (e.g. ASR 33). The characters are transmitted via data lines D1 to D7. The transmission is bidirectional, i.e. the same lines are used for both the input and output of commands.

2.5.3 Level

All characters are transmitted with TTL levels in negative logic:
Voltages above 3.2 V represent high potential and thus logic 0 and
voltages below 0.8 V represent low potential and thus logic 1.

2.5.4 Sequence of Data Transmission

Programming of the SMPU is performed according to an asynchronous method: When combining several instruments, the system always waits for the slowest instrument used. This is enabled by the three lines DAV (data valid), RFD (ready for data) and DAC (data accepted). Basically data transmission is as follows:

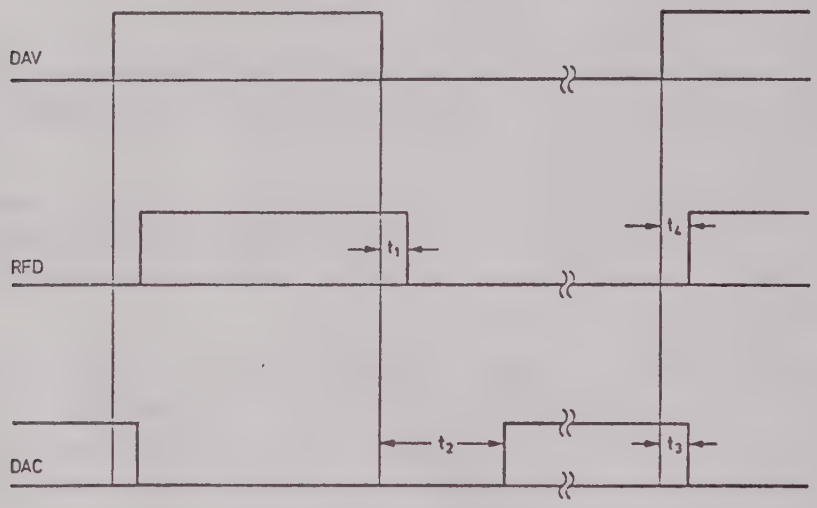


Fig. 2-4 Sequence of data transmission

Prior to data transmission all instruments must be ready to receive data. This is the case if the RFD line is at high potential. Since all RFD lines are paralleled with open collectors, RFD switches to high only if the RFD lines of all listeners are at high potential. Next the talker sets the DAV line to low and the data present on lines D1 to D7 become valid.

The listeners accept the data and acknowledge completion of processing by switching their DAC lines to high potential. The DAC lines are also paralleled with open collectors so that the talker receives the DAC signal only if all listeners have delivered the DAC signal. Next the talker switches the DAV signal back to high and interrogates the RFD line again in order to apply the next data to the data bus.

2.5.5 Addressing

If several instruments are used on a common data bus, each of them has to be provided with an address. Only in this way can the individual instruments be controlled and is it possible to distinguish between data transmitter (talker) and data receiver (listener). The address is also transmitted in the form of a 7-bit ASCII character. The ATN line enables the distinction between data and address. During data transmission the ATN line is at high potential, during transmission of an instrument address it is set to low.

2.5.6 RFD Line

The RFD line of the SMPU is at high potential if the SMPU is ready to receive data. The line is at low potential if the SMPU is not in the ready mode, i.e. if a button is pressed, the program switch is set to manual operation or the BUSY lamp is on. The latter is the case if an automatic test routine is being executed. Therefore, the program control unit can recognize from the logic level of the RFD line when a test routine started in the SMPU is completed.

2.5.7 DAC Line

By switching from low to high, the DAC line signals that a command or data entry has been understood. In general, the DAC signal appears a few 100 µsec after the trailing edge of the DAV signal (t_2 in Fig. 2-4).

2.5.8 IFC Line

A low signal on the IFC line erases both addresses of the SMPU. In addition, activation of the IFC line corresponds to pressing the red CLEAR button 24 . In this way, the microcomputer is reset and the ongoing test routine interrupted.

2.6 Programming Example

Comments	Program	SMPU data output	Data sequence on IEC bus
Receive address Transmitter measurement Output: transmitter power Send address	/ J W M X 0		/ J W M X 0
Output: 05003 $\hat{=}$ $(500^2 \cdot 10^{-6} + 0.005) \cdot 25$ $= 6.375$		0 5 0 0 3 CRT	0 5 0 0 3 CRT
Receive address Output: transmitter frequency Send address	/ A W 0		/ A W 0
Output: 146.19023 MHz		1 4 6 1 9 0 2 3 CRT	1 4 6 1 9 0 2 3 CRT
Receive address Receiver measurement 2.8 kHz FM Switch on distortion meter Output: distortion Send address	/ @ U 2 . 8 A H Q M ← 0		/ @ U 2 . 8 A H Q M ← 0
Output: 0750C = 7.5%		0 7 5 0 C CRT	0 7 5 0 C CRT
Receive address Switch off distortion meter Modulation off CCITT filter on	/ N Q @ [F Y		/ N Q @ [F Y

2.7 Programming of SMPU with Card Reader PCL

All settings on the SMPU can be made with the aid of program cards. For this purpose, it is best to use the Card Reader PCL which can be directly connected to the SMPU data connector 77 . In accordance with the programming instructions (see section 2.4), the receive address / or a modified address is first perforated on the card. Next, all programming commands are entered in the required order and sequence according to Table 2-5; for coding see Table 2-3.

Note: The scanning speed of the Card Reader PCL is about 25 msec/character. Since reading cannot be delayed, only such commands can follow one another on a card which are executed at the lastest after 25 msec. This is the case with all SMPU programming commands. Exceptions are the automatic test routines (buttons 45 , 46 , 54 , 55). For this reason, calling of a test routine should always be the last command on a program card.

2.8 Combining the SMPU with a Printer

A printer can be directly connected to the SMPU data connector 77 . In addition to IEC-compatible printers, BCD-controlled printers can be used; however, the latter have to be interfaced to the IEC bus via Code Converter PCW.

To start printing an additional control unit is required; it releases the SMPU data output by the corresponding programming commands and controls the printer. In the simplest case, the Card Reader PCL can be used for this purpose. Because of the scanning time, make sure that the print command is always entered at the end of the card when using the PCL. The last character is in any case the send address of the SMPU.

2.9 Controlling the SMPU from a Desk-top Calculator

Optimum use of the SMPU facilities is ensured when combining the set with a calculator. A favourably priced solution is to use a desk-top calculator. On principle, any model which is compatible with the IEC bus is suitable for this purpose.

Rohde & Schwarz recommends use of the Tektronix Desk-top Calculator TEK 31 and of the associated IEC Interface SMPU-Z2. This combination enables fully automatic measurements with data logging. In addition, the necessary software is available for this assembly.

Contact	Connection
A	Transmitter measurement
B	
C	Call
D	
E ⊥	
F	
G	Receiver measurement
H	Squelch
I	

Table 2-1 Contact occupation of CONTR. socket

Pin No.				Pin No.
1	D1		D5	13
2	D2	Data lines	D6	14
3	D3		D7	15
4	D4		–	16
5	–		–	17
6	DAV			18
7	RFD			19
8	DAC	Transmission control lines		20
9	IFC		⊥	21
10	–			22
11	ATN			23
12	⊥			24

DAV (data valid)
Clock signal from data transmitter for marking the interval in which the data is valid

RFD (ready for data)
Ready signal of SMPU for data transfer

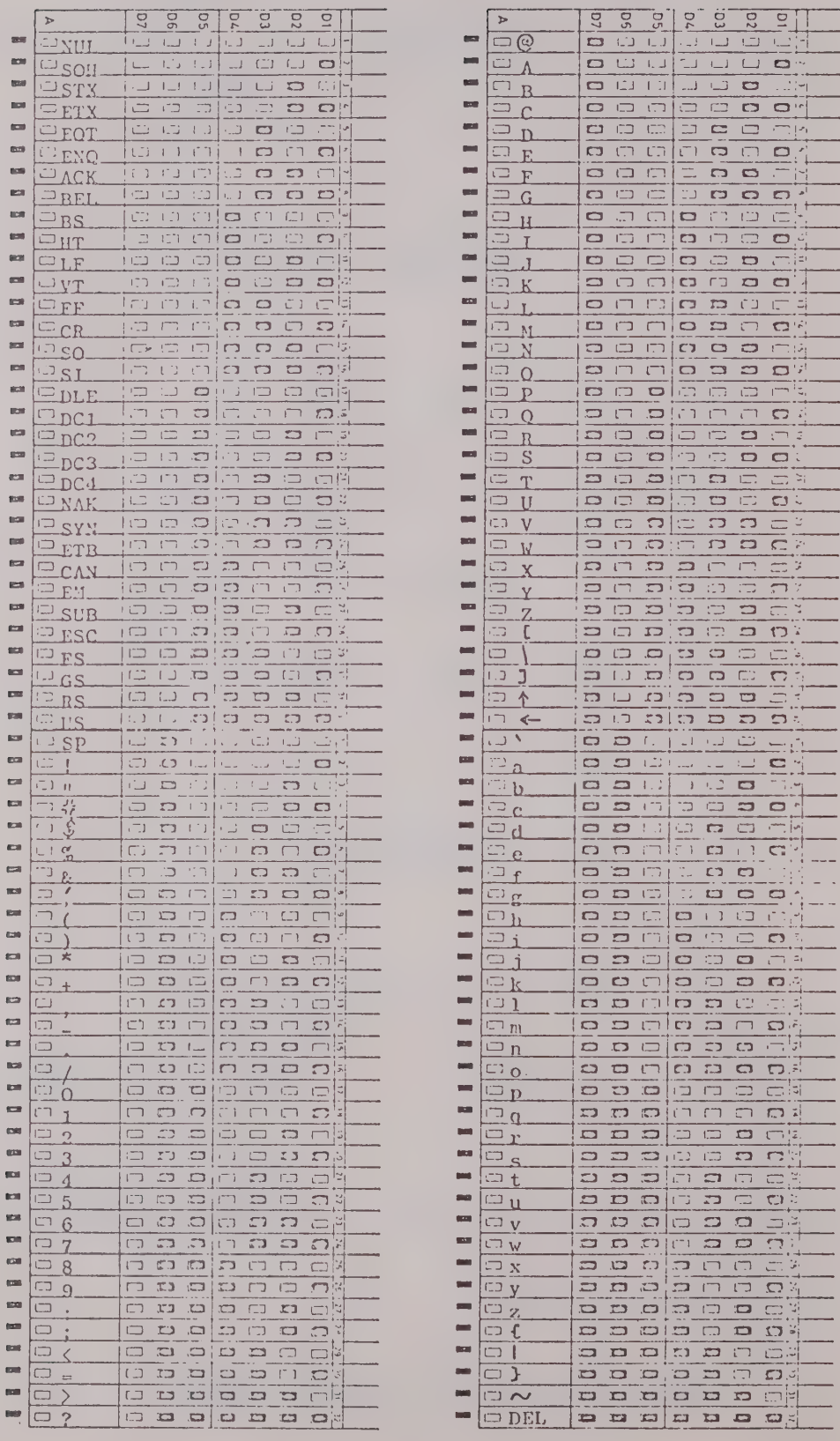
DAC (data accepted)
Acknowledgement signal of SMPU for received data

ATN (attention)
Signal for SMPU enabling distinction between data and instrument address

IFC (interface clear)
Signal from data transmitter for setting the instruments to a defined starting point

Table 2-2 Occupation of SMPU IEC data connector

Tab. 2-1
2-2


A
D7 D6 D5 D4 D3 D2 D1
NUL SOH STX ETX EOT ENQ ACK BEL BS HT LF VT FF CR SO SI DLE DC1 DC2 DC3 DC4 NAK SYN ETB CAN EM SUB ESC FS GS RS US SP ! " # $ % & ' ( ) * + , - . / 0 1 2 3 4 5 6 7 8 9 : ; < = > ?
@ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [\ ] ↑ ← ` a b c d e f g h i j k l m n o p q r s t u v w x y z { | } ~ DEL

■ ≙ 1
□ ≙ 0

Table 2-3 7-bit ASCII

Switch position E	D	C	B	A	Data receive address	Data send address
0	0	0	0	0	Space	@
0	0	0	0	1	!	A
0	0	0	1	0	"	B
0	0	0	1	1	#	C
0	0	1	0	0	$	D
0	0	1	0	1	%	E
0	0	1	1	0	&	F
0	0	1	1	1	'	G
0	1	0	0	0	(	H
0	1	0	0	1	)	I
0	1	0	1	0	*	J
0	1	0	1	1	+	K
0	1	1	0	0	,	L
0	1	1	0	1	-	M
0	1	1	1	0	.	N
0	1	1	1	1*)	/	O
1	0	0	0	0	0	P
1	0	0	0	1	1	Q
1	0	0	1	0	2	R
1	0	0	1	1	3	S
1	0	1	0	0	4	T
1	0	1	0	1	5	U
1	0	1	1	0	6	V
1	0	1	1	1	7	W
1	1	0	0	0	8	X
1	1	0	0	1	9	Y
1	1	0	1	0	:	Z
1	1	0	1	1	;	[
1	1	1	0	0	<	\
1	1	1	0	1	=	]
1	1	1	1	0	>	^
1	1	1	1	1	not permissible	

The desired addresses are set by adjusting the necessary 0-1 combination on the data coupler board with switch B6.

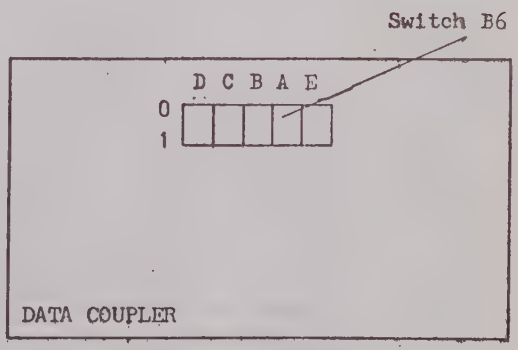


Table 2-4 SMPU addresses

*) factory-adjusted

Tab. 2-4

Table 2-5 Programming Commands

Command	Name	Function	Linkage
@ ←	H/RF	Reading in RF generator frequency Format: 3 digits before decimal point 5 digits after decimal point Physical unit: MHz	None
B ←	DB	Reading in RF generator level Format: 3 digits before decimal point Physical unit: dB	None
D ←	H/DELT	Reading in frequency step δf Format: 6 digits before decimal point 2 digits after decimal point Physical unit: kHz	None
F ←	V	Reading in AF generator level Format: 1 digit before decimal point 2 digits after decimal point Physical unit: V	Modulation off
I ←	CT	Reading in modulation depth in AM mode Format: 2 digits before decimal point Physical unity: %	AF generator off
A ↑	H/FM	Reading in frequency deviation in FM mode Format: 2 digits before decimal point 1 digit after decimal point Physical unit: kHz	AF generator off
E ↑	RD	Reading in phase deviation in φM mode Format: 2 digits before decimal point 1 digit after decimal point Physical unit: rad	AF generator off
I ↑	H/LF	Reading in AF generator frequency Format: 3 digits with floating point in range 10 Hz - 99.9 kHz Physical unit: kHz	None
L ↑	LFGE	AF generator on	AF counter and modulation off
E]	AFEX	External AF generator on	AF counter on, internal AF generator off
J]	RFOF	RF generator off	None
K]	RFGE	RF generator on	None
A \	MVAR	Reducing the last quantity addressed by one step Physical unit: depends on last quantity addressed	None
B \	PHMO	Phase modulation on	AF generator and frequency modulation off; modulation on

Command	Name	Function	Linkage
G \	FMMO	Frequency modulation on	AF generator and phase modulation off; modulation on
L \	AMMO	Amplitude modulation on	AF generator off; modulation on
@ [	MOFF	All modulation modes off	None
A [	MODU	Switching on stored modulation modes	AF generator and AF counter off
J [	AMDC	Electronic fine tuning on	AM must be entered via FM!
K [	FMDC	Switching over frequency modulation to DC mode and disabling synchronization	None
L [	AMEX	Switching over amplitude modulation to external modulation generator	None
M [	FMEX	Switching over frequency modulation to external modulation generator	None
N [	MOAI	Switching over both amplitude and frequency modulation to internal modulation generator and AC mode; switching on level control and synchronization	Clears AMDC, FMOC, AMEX, FMEX
O [	PLDF	Advancing carrier frequency by positive δf	None
B Z	MIOF	Advancing carrier frequency by negative δf	None
D Z	VADB	Switching on variation of carrier frequency level	None
F Z	VAMO	Switching on variation of AM, FM, φM or AF generator level. The last quantity selected is varied. With simultaneous AM and FM, the frequency modulation is varied.	None
H Z	VAAF	Switching on variation of AF generator frequency. The last of the three digits set is varied.	None
J Z	V1RF	Switching on variation of carrier frequency; resolution 10 Hz	None
L Z	V2RF	Switching on variation of carrier frequency; resolution 1 kHz	None
N Z	V3RF	Switching on variation of carrier frequency; resolution 100 kHz	None
@ Y	MOM1	Modulation measurement range 1; full-scale deflection with FM 5 kHz, with AM 30%, with φM 2 rad	None
A Y	MOM2	Modulation measurement range 2; full-scale deflection with FM 20 kHz, with AM 100%, with φM 5 rad	None

Command	Name	Function	Linkage
C Y	MULMO	Increasing sensitivity of modulation measurement ranges 1 and 2 by a factor of 100	None
B Y	MUOF	Normal sensitivity of modulation measurement ranges 1 and 2	None
E Y	FILT	CCITT filter on	None
F Y	FIOF	CCITT filter off	None
H Y	FMME	Setting modulation meter to FM; mode remains stored	PM and AM measurements are erased
K Y	PMME	Setting modulation meter to φM; mode remains stored	FM and AM measurements are erased
N Y	AMME	Setting modulation meter to AM; mode remains stored	FM and PM measurements are erased
A X	NEIN	Setting modulation meter to negative peak indication	None
@ X	POIN	Setting modulation meter to positive peak indication	None
C X	MOCL	Clearing modulation modes	AM, FM and φM are disabled.
F X	LFOF	All AF generators off to enable measurement of residual FM of radio set	AF generator off; modulation meter sensitivity increased by a factor of 100
K X	DCEXT	Outputting external DC voltage applied to ADC socket	None
D W	ANOF	Analyzer off	None
E W	ANAL	Analyzer on; switching the signal to be analyzed to output ANALAS. and the RF generator signal to output RF 2	AF generator, AF level meter and AF counter off; positive modulation indication
J W	XMTE	Transmitter measurement	RF power meter on; RF counter on; modulation meter on; AF generator on; positive modulation indication; RF generator off; AF counter off; analyzer off; AF level meter off
L V	DUTE	Duplexer measurement	RF power meter on; RF generator on; modulation on; RF counter off; AF counter off; AF generator off

Command	Name	Function	Linkage
@ U	RETE	Receiver measurement	RF generator on; AF level meter on; modulation on; RF power meter off; RF counter off; AF generator off; AF counter off
F T	POBA	Program, positive bandwidth	Same as receiver measurement, however, modulation off
J T	NEBA	Program, negative bandwidth	Same as receiver measurement, however, modulation off
N T	SQUP	Program, lower squelch response level (disabling squelch)	Same as receiver measurement, however, with squelch switched on
B S	SQDN	Program, upper squelch response level (cutting in squelch)	Same as receiver measurement, however, with squelch switched on
J S	SE20	Program, sensitivity measurement for 20-dB S/N ratio	Same as receiver measurement
O S	SE12	Program, sensitivity measurement for 12-dB S/N ratio	Same as receiver measurement
M R	CHECK	Self-testing	RF generator on; RF counter on; AF generator on; AF counter on; AF level meter on
H Q	DI1K	Switching on distortion measurement at 1 kHz	Distortion measurement at 300 Hz off
J Q	DI3H	Switching on distortion measurement at 300 Hz	Distortion measurement at 1 kHz off
N Q	DIOF	Distortion measurement off	None
B P	SINO	Program, S/N ratio	None
L P	PVAR	Increasing last quantity addressed by one step Physical unit: depends on last quantity addressed	None
O←	OVAR	Outputting varied quantity; depending on last variation address entered	None
M X	OUDB	Outputting RF level meter reading	None
A W	OURF	Outputting RF counter reading	None
M←	OUAF	Outputting AF counter reading or test result of a test routine	None

Command	Name	Function	Linkage
0 X	OUMO	Outputting AF level meter or modulation meter reading (modulation meter reading delivered without range indication)	None

Table 2-6 Output Formats

Name	Output	Format
OUDB	RF level meter reading Note: For meaning of numbers printed see section 2.4.4.2	Digits 1 to 4 correspond to level value, max. 1024; digit 5 corresponds to measurement range (see section 2.4.4.2)
OURF OURF with preceding POBA	RF frequency counter reading Frequency difference between positive 6-dB point and centre frequency	8 digits, resolution 10 Hz 8 digits, resolution 10 Hz
OURF with preceding NEBA	Frequency difference between negative 6-dB point and centre frequency	8 digits, resolution 10 Hz
OUMO with preceding XMTE	Modulation meter reading AM, FM or φM depending on AMTE, FMTE or PMTE mode; measurement range depending on modulation measurement ranges MOM1 and MOM2 and multiplier MUMO	Digits 1 to 4 correspond to measured value; digit 5 is not valid.
OUMO with preceding RETE or DUTE	AF level meter reading; scale factor depending on modulation measurement range selected	Digits 1 to 4 correspond to measured value; max. 1024; digit 5 corresponds to measurement range: 0 ≙ 3 mV 1 ≙ 10 mV 2 ≙ 30 mV 3 ≙ 100 mV 4 ≙ 300 mV 5 ≙ 1 V 6 ≙ 3 V 7 ≙ 10 V
DCEXT	DC voltage at ADC input	Digits 1 to 4 correspond to measured value; digit 5 is not valid.
OVAR	Last variation quantity addressed	
OVAR with preceding VADB	Varied RF generator level	3 digits, resolution 1 dB
OVAR with preceding VAMO	Variation quantity; AM, FM, φM or AF generator level (depending on the last quantity varied)	AM: 2 digits, in % FM: 3 digits, resolution 100 Hz φM: 3 digits, resolution 0.01 rad AF generator level: 3 digits, resolution 10 mV

Name	Output	Format
OVAR with preceding VARF	Varied RF generator frequency	8 digits, resolution 10 Hz
OVAR with preceding V1RF	Varied carrier frequency	8 digits, resolution 10 Hz
OVAR with preceding V2RF	Varied carrier frequency	6 digits, resolution 1 kHz
OVAR with preceding V3RF	Varied carrier frequency	4 digits, resolution 100 kHz
OVAR with preceding VAAF	Varied AF generator frequency	Digits 2 to 4 correspond to measured value; digit 1 corresponds to frequency range : 0 ≙ 10 - 100 Hz 1 ≙ 100 Hz - 1 kHz 2 ≙ 1 kHz - 10 kHz 3 ≙ 10 kHz - 100 kHz
OUAF	AF frequency counter reading	5 digits, resolution 1 Hz
OUAF with preceding DI1K or DI3K	Distortion	Digits 1 to 3 correspond to measured value, resolution 0.1%; digit 4 is not valid; digit 5 refers to distortion measurement.

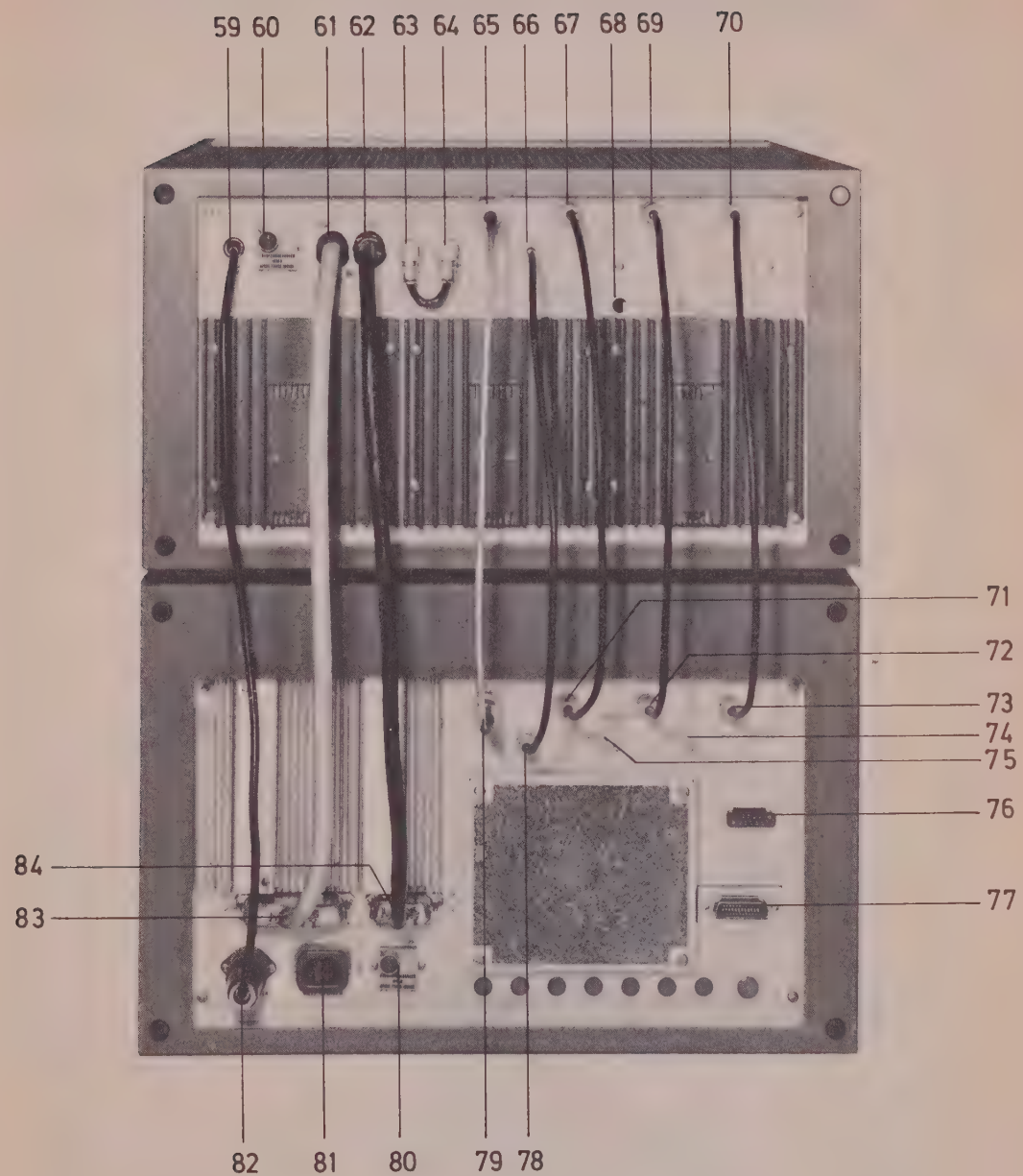
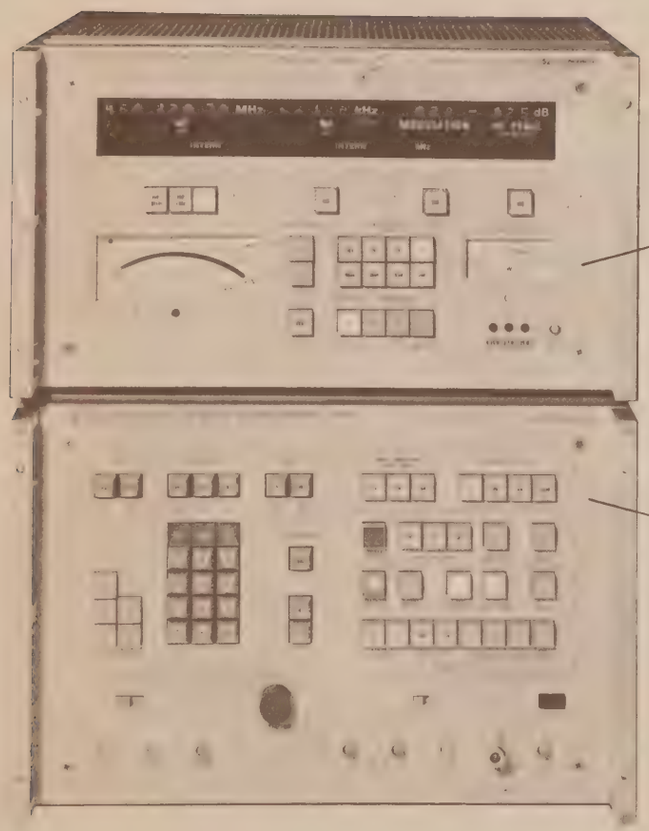


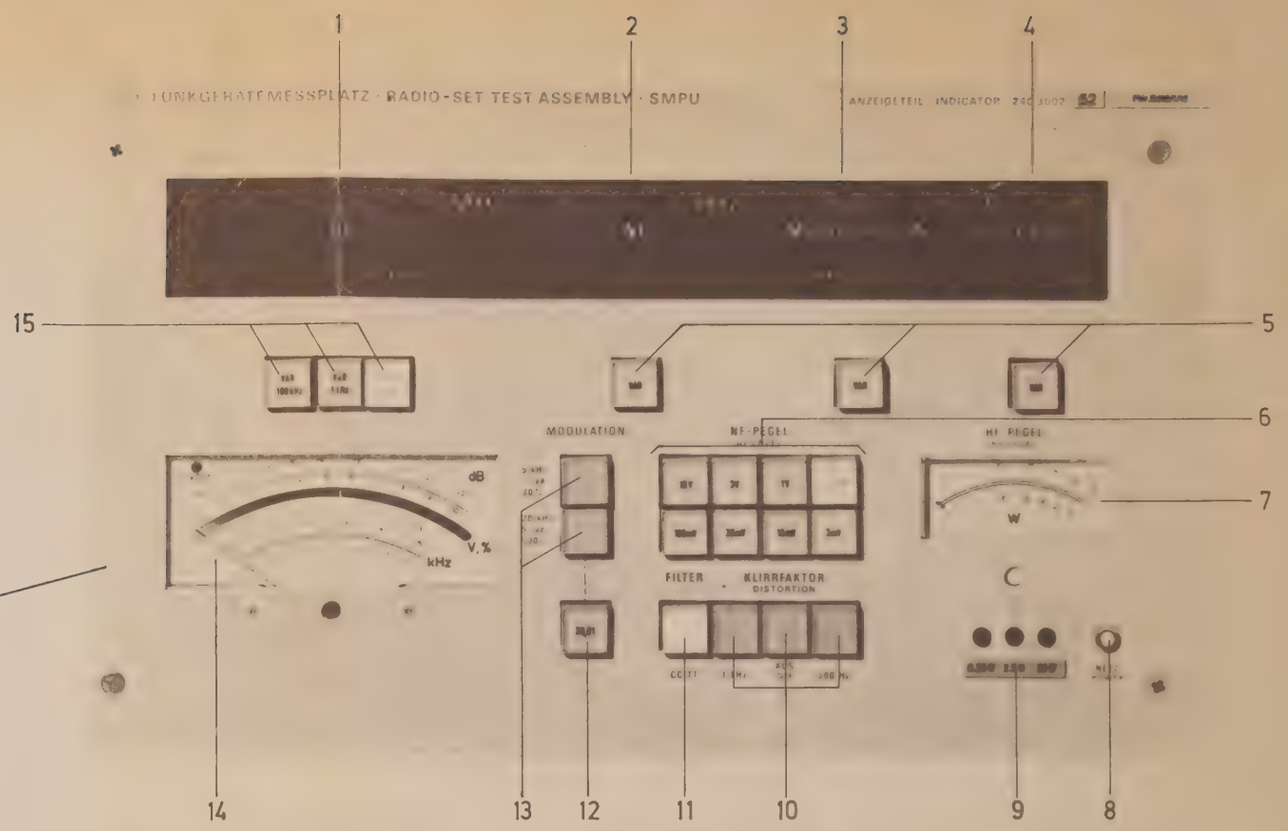
Bild 2-2 Bedienbild Rückseite

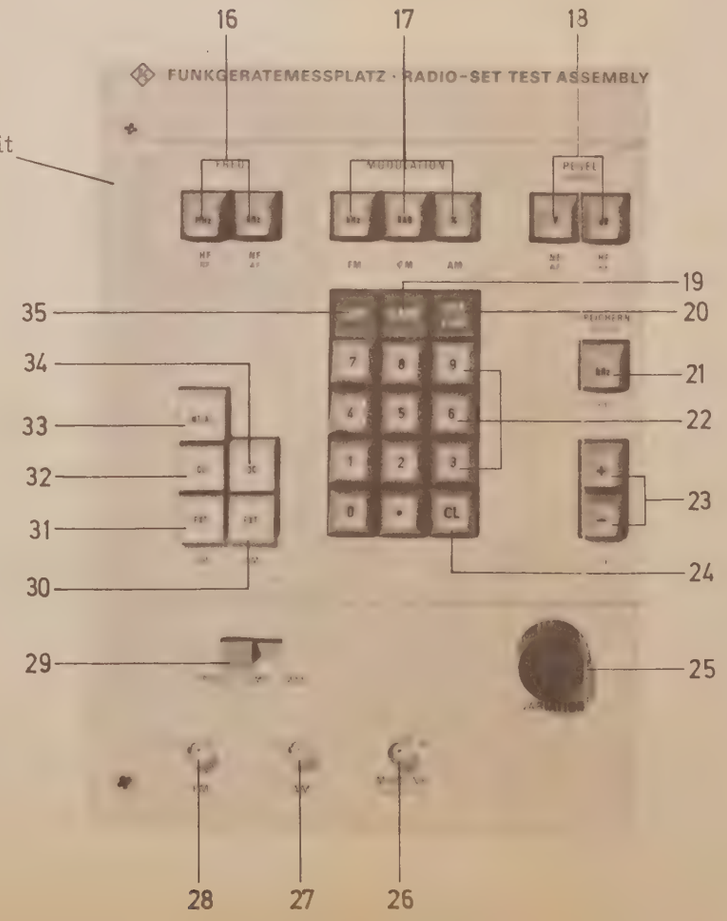
Fig. 2-2 Rear panel



Anzeigeteil
Indicator

Steuerteil
Control unit





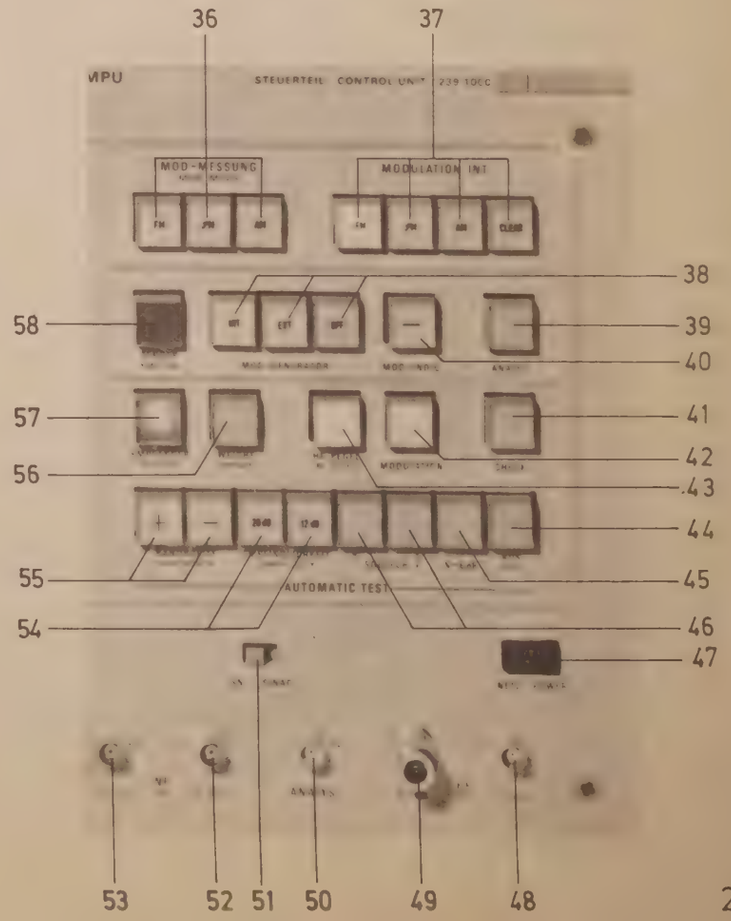


Bild 2-1 Bedienbild Frontseite

Fig. 2-1 Front panel

Receive address: Setting command see Table 2-4
Reset command ?

Send address: Setting command see Table 2-4
Reset command →

Command	Output
AW	RF frequency
M ←	AF frequency
O ←	Varied quantity
OX	Modulation or AF level
MX	RF level
KX	DC voltage at ADC socket

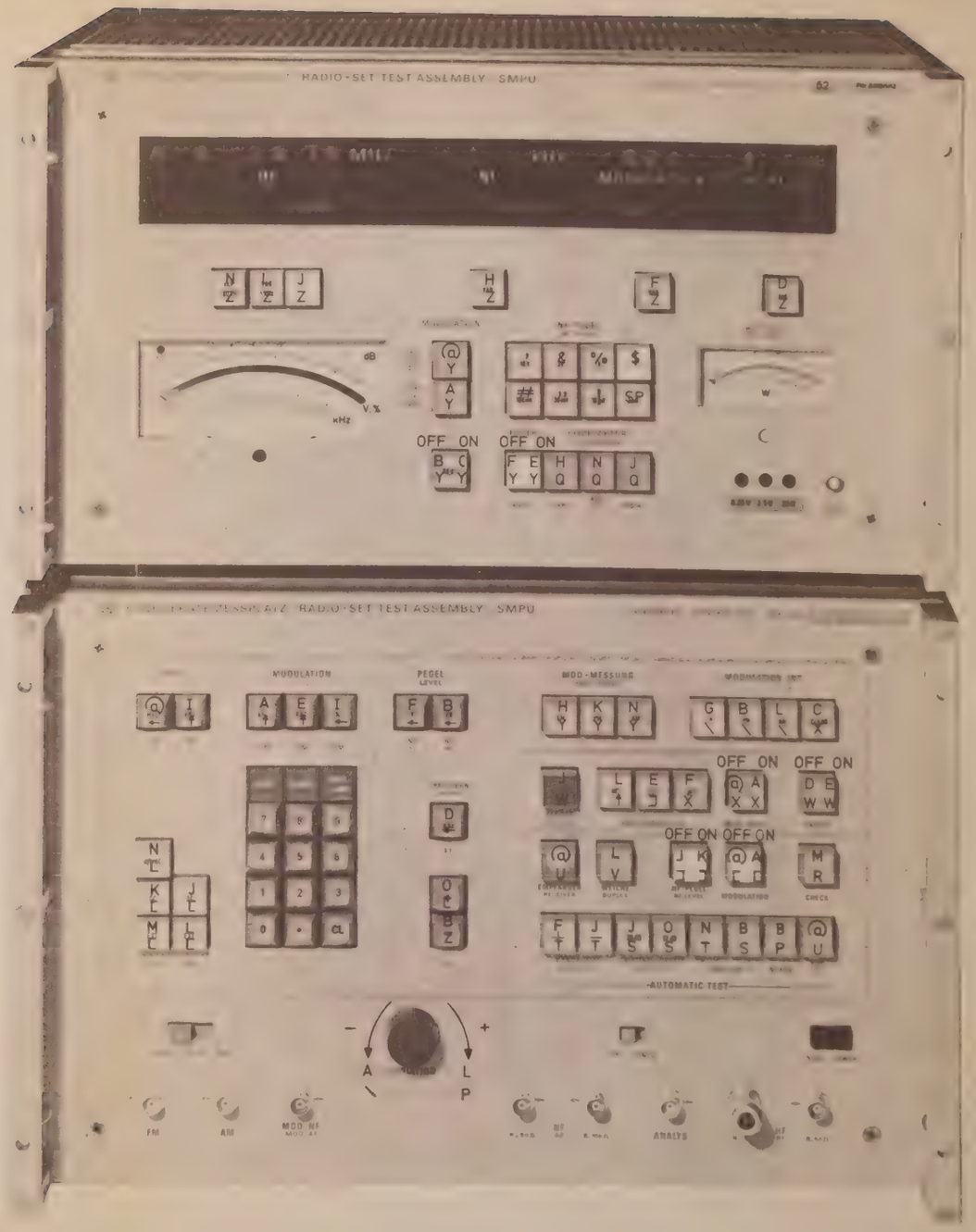


Fig. 2-3 Association of programming commands with SMPU panel controls

17.

ROHDE & SCHWARZ
MÜNCHEN

Manual

SOFTWARE FOR CONTROL SMPU WITH 4051 SMPU-K1

240.6518.02

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1. What the Basic Software Can Do and how to Use it

Using the desktop calculator TEK 4051 as a controller extends the Automatic Test Set for Radiotelephones to a comfortable, fully automated test system providing for all features of modern automatic measurement technique. In order to ease the handling of the system "SMPU - TEK 4051" a comprehensive Basic Software was established. The Basic Software is contained in a magnetic cartridge for the TEK 4051.

The Basic Software contains many ready made measuring routines, which can be called up by their respective code numbers (see Table 1). Thus it is possible to write a program even without the actual knowledge of real programming. Nonetheless, the Basic Software does not limit the user to the prefabricated measuring routines, because the Basic Software contains additional subroutines which enable the user to establish programs that lie outside the scope of the normal measuring routines. This is essential for the test of subassemblies or of communication instruments which are not conforming to normal transceivers and it is indispensable in the application in a development laboratory.

By virtue of this characteristic of the Basic Software the user can decide whether to work with the ready made measurement subroutines or to work with programs tailored to his specific needs. In addition there is the possibility to optimize the programs concerning measurement speed and reproduceability.

1.1 The Parts of the Automatic Test System

The minimum ATS contains the Automatic Test Assembly for Radio Communication SMPU and the desk top calculator Tektronix 4051. The storage capacity of the calculator 4051 should be at least 24 k Bytes (Option 21), because

the Basic Software SMPU - K 1 covers approximately 20 k Bytes.
It is possible to connect an external printer to the desk top calculator. The printer must be compatible to V 24, RS 232 C. In order to match the printer with the calculator, the TEK 4051 must be equipped with the Output Interface Option 10. The Option 10 contains also the necessary cable : calculator-printer.
The extension of the System SMPU + TEK 4051 for further kinds of measurements is easily done by connecting IEC - - Bus compatible measuring instruments.
The Basic Software SMPU - K 1 already contains sub-routines for the extension with a codeconverter PCW for the control of the test item, for the control of a power supply and for the management of the two transmitter measurement.

2. Set-up of the System

2.1 Switching on the Test Assembly

SMPU and desk top calculator 4051 are connected by a 24-pole Amphenol cable. The slide switch on the left side of the front panel of the SMPU must be set on position "PROG" or on position "COMB". After Switching on the 4051 the display screen is cleared by pressing the key "HOME PAGE" on its keyboard. For the loading procedure of the program the magnetic cartridge must be inserted into the appropriate slot on the right side of the calculator.

2.2 Characteristics of the Basic Software Cartridge

The Basic Software for control of the SMPU by TEK 4051 is supplied on a magnetic cartridge fitting for the TEK 4051. The cartridge is protected against erraneous erasing of its contents. This is clearly visible from outside by the position of the slot of a screw which points in the direction "SAFE".
Normally, this setting should not be changed.The Basic Software Cartridge should only be used to load the

Basic Software into the solid state store of the TEK 4051. Measuring programs are then transferred on a new cartridge together with the Basic Software.

2.3 Loading the Basic Software into the Desktop Calculator

The Basic Software is read into the solid state store of the TEK 4051 by the following orders:

```
FIND  1          press key "Return"
OLD              press key "Return"
```

This is a general rule: finish all lines in your program on the keyboard by pressing the key "Return" (see 3.1).

2.4 How to Divide Empty Cartridges into Files

Completed programs can be transferred onto magnetic cartridges. Before the store routine is possible the cartridge has to be divided into files. This is done by the following orders:

```
FIND  0
MARK 10 , 20 000
```

By this procedure the cartridge is divided into 10 files containing 20 000 lines each.

ATTENTION: This a.m. order erases the whole tape. So this procedure should be used only if either the tape is empty or the programs stored on the tape or no more necessary.

2.5 How to Store Programs on a Cartridge

Completed programs are transferred from the solid state store to the tape by the orders:

```
FIND  X
SAVE
```

The number X signifies the file to be used. If the tape is divided into 10 files according to chapter 2.4 , the number X can be any number between 1 and 10.

2.6 How to Call up Programs from a Cartridge

Programs that are stored on a cartridge are transferred to the solid state store by the orders:

```
FIND  X
OLD
```

Here, the number X signifies the file where the specific program is stored. That means you can have several different programs on one tape.

3. How to Program Using the Subroutines of the SMPU - K 1

After reading the Basic Software into the solid state store the subroutine 18 must be programmed, thus putting the 4051 into a clearly defined starting condition (see chapter 4).

3.1 How to Program

Each program step is assigned to a specific address: a line number. Normally a program starts at line number 100. This is arranged for automatically by pressing the key "AUTO NUMBER". The usual increment for the line number is 10, thus enabling the user to insert up to 9 new lines between the already existing two lines.

ATTENTION: Line number 1 to 99 and 9000 to 10 000 are covered by the Basic Software and must not be used for user's program.

After writing a program line it will only be stored if the key "RETURN" is pressed.
If there is a faulty line which is not to be stored, the key "RETURN must not be pressed. Depress instead the key "CLEAR".

Examples for : store - do not store - cancel

	line number	program	Press key
a)	100	GOS 44	RETURN

this will effect the storage of : 100 GOS 44

	line number	program	Press key
b)	100	GOS 66	CLEAR

Now there will still be in the store: 100 GOS 44

c)	100		CLEAR

Still in the storage: 100 GOS 44

d)	100		RETURN

This effects that the line 100 is cancelled in the solid state store.

3.2 Listing of Programs

Programs are listed by the order : LIST X,Y. Here, X is the first line, Y is the last line to be listed.

3.3 Changing of Programs

If a program line is to be changed this is accomplished by writing the new program into that very line.
In order to cancel a line, the line number is called up and after that the key "RETURN" is actuated.

3.4 Detection of Programming Errors by the Calculator

Normally prohibited program steps are detected by the calculator's self check facility and are marked by the comment "ERROR".
If this occurs, press the key "CLEAR" and program the line once more in a correct way.
The Basic Software SMPU - K 1 contains 99 subroutines which can be used in a modular form to write specific measuring programs.

3.5 How to Feed in Data and Working Modes

Before programming the actual measurements there has to be done the set up of the measuring instrument and of the test item. The set up of the data (frequency, voltage levels, etc.) is done by the subroutines number 1 to 17.

The following format is used here:

Y = value of the data
GOS (Code number of Subroutine 1 - 17)

EXAMPLE: Set the SMPU to e.g. 123.456 MHz

```
100       Y = 123.456
110       GOS 1
```

or set the AF-level to 1,5 Volt

```
120       Y = 1,5
130       GOS 6
```

There is basically only the necessity to program the setup of those data, that will be needed for the following measurement.
The setting of the RF-frequency can be done either with subroutine 1 or also in the form of its channel number, using subroutines 8, 9, 10, 11 and 12.
If the user wants to feed in data in the form of a dialog, the order: "INPUT" must be used.

EXAMPLE: Input of the channel number via dialog:

```
330    PRINT  "NUMBER OF CHANNEL? G G G G G
340    INPUT  Y
350    GOSUB  8
```

The calculator stops at line 340, the question mark of line 330 flashes; now the operator has to type the channel number and then has to press the key "RETURN" . The statement INPUT Y effects the transfer of Y = 450 into the subroutine 8.

ATTENTION: The S/N-ration of subroutine 17 (e.g. 6, 10, 12, 20, or 26 dB) has to be programmed for receiver test at any rate, because this ratio is needed for the sensitivity measurement (GOS 42), for the image frequency rejection measurement (GOS 55) and for the duplex measurement.

3.6 Working Modes

Concerning the working modes of the SMPU the user has to choose one of them, i.e. either transmitter test (19) or receiver test (20).
Besides, the user must select one of the five possible kinds of modulation: AM, PM, FM, AM + FM, AM + PM (21-25).
The selected modulation is valid for receiver test and for transmitter test.
The modes Sweep (28), Analyzer (29) and Selfcheck (30) are reset to normal operation (i.e. receiver test) by the subroutine 20 (receiver test).

3.7 How to Program Control Lines

The SMPU automatically actuates the built-in relais matrix for the control of the radio telephone, i.e. the control of the transmit-receive key, of the squelch circuit and of the call tone generator.
By adding a Codeconverter PCW the user additionally can dispose of 8 single action control lines and also of a four digit channel control line.
The setup of a single action control line is done by subroutine 31, the reset is done by subroutine 32. The number of the control line to be used (set or reset) is entered via the parameter Y.

EXAMPLE:

```
200     Y = 5
210     GOS 31
```

This program sets the control line 5.

```
200     Y = 5
230     GOS 32
```

This program switches off the function controlled by line 5.

3.8 How to Program Measurements

All the measurement routines 44 to 82 are called up by the statement: GOS (number of subroutine)

EXAMPLE: AF-level measurement

```
100     GOS  61
```

or: measurement of the frequency of the call tone generator of the transceiver. (TX-test)

```
110   GOS  70
```

The result of all these measuring routines (44 to 82) is transferred into the store address Y and is edited by the order: GOS 86 (with tolerance evaluation)
or PRI Y (without tolerance evaluation)
The subroutine GOS 86 should preferably be used also if no tolerance evaluation is wanted. In this case the input procedure for the high and for the low level are left off.

3.9 How to Insert Text into the Protocol

If the test protocol is to contain text it can be achieved by the following order: PRINT "Text";

EXAMPLE: Printout of the words Power Measurement:

```
120   PRINT  "Power Measurement";
```

NB: The sign ; (semicolon) after the text keeps the calculator from going to the next line in the printout (no line feed). Thus it is possible to have the commentary text and measurement's result in one line.

3.10 Examples of Programs with their Protocol

a) Power measurement:

```
100   GOS  68
110   PRI  "POWER :";
120   GOS  86
130   PRI  "WATT"
Result:  POWER:  1,23 WATT
```

b) Sensitivity measurement:

```
140   GOS  44
150   PRI "SENSITIVITY:";
160   GOS  86
170   PRI "dBV"
Result:  SENSITIVITY : 123,5 dBV
```

3.11 Comments on some Subroutines for Receiver Test

42 and 43: The sensitivity measurement 42 and 43 uses the S/N-Ratio or the SINAD ratio selected by subroutine 17. The slide switch S/N-SINAD on the SMPU has to be set to the proper position.

44 and 45: sensitivity measurements using the firmware programs of the SMPU with 12 or 20 dB S/N or SINAD ratio.

46: The bandwidth measurement is for both, the positive and the negative 6 dB point. The result of this subroutine is the total bandwidth. The result of the positive 6 dB point is available by putting Y = Y2 before GOS 86.
The same is valid for the negative 6 dB point (Y=Y3), and for the midfrequency shift (Y = Y 4).

EXAMPLE: Measurement of the total bandwidth and of the midfrequency shift:

```
100    GOS  46
110    PRI  "BANDWIDTH"
120    GOS  86
130    PRI  "KHz"
140    Y = Y4
150    PRI  "MIDFREQU.SHIFT:";
160    GOS  86
170    PRI  "KHz"
```

Result: BANDWIDTH: 15,6 KHz
MIDFREQU.SHIFT: 1.9 KHz

47 and 48: these routines measure the positive and negative 6dB point separately.

49: squelch-hysteresis: the result (Y) of this subroutine is the hysteresis of the squelch circuit. by setting Y = Y 2 or Y = Y 3 the upper and lower squelch trigger level are output seperately.

EXAMPLE: Measurement of squelch-hysteresis in dB and of upper squelch trigger level in mmV.

```
100   PRI  "SQUELCH HYST.:";
110   GOS   49
120   GOS   86
130   PRI  "dB"
140   PRI  "SQELCH ON:";
150   Y = Y 2
160   GOS   41
170   GOS   86
180   PRI  "mmV"
```

50 and 51: upper and lower squelch trigger level are measured and output seperately.

52: measurement of audio frequency characteristic in dB in reference to the result of the measurement at 1 kHz. The actual test-frequency is read in by routine 2. The reference measurement at 1 kHz is contained in routine 52.

53 and 54: measurement of the signal to noise ratio according to the S/N - or SINAD-method (set slide switch on SMPU!) at that RF-level which is given by the value read in by routine 7.

55: the measurement of the image frequency rejection is performed at an RF-frequency that is two times the IF up or down from the receiver frequency depending on the mixer action of the transceiver (mix up or mix down). The frequency of the IF is read in by the routine 13 with positive or negative sign, also depending on the mixer of transceiver.

57: tuning of the antennas directional coupler (duplex mode). The routine 57 measures the sensitivity for the S/N-ratio given by routine 17 while the transmitter is keyed simultaneously.
The program stops after this measurement so the operator can tune the duplex circuit to minimum

noise performance which can easily be read off the AF-level meter. When the tuning procedure is completed the program is stopped by pressing the key "RETURN".

56: measurement of the duplexer's performance: the result of this measurement is the change in sensitivity if the transmitter of the transceiver is switched on and off.
Dimension: dB. For this measurement it is necessary to connect the transmit key of the transceiver to the proper control relais built into the SMPU. That means, the transceiver must transmit when the key "TX-test" on the SMPU lights up.
If the transceiver is not controlled automatically by the SMPU (via the built in relais matrix) the Basic Software has to be changed in a manner that a halt is being inserted in the program.
The program line 9285 in SMPU - K 1 has to be changed:

old form: 9285 PRINT @ 15: "JWLV"
new form: 9285 GOS 85

Thus the program is stopped enabling the operator to actuate the proper switch on the transceiver. After this operation the program is restarted by pressing the key "RETURN".

58 and 59: dynamic adjacent channel selection. For this measurement two RF-signal generators are required. The software routine of SMPU - K 1 is constructed so that the second signal generator may be either the combination of Codeconverter PCW, universal Signal Generator SMDU with Programmable Attenuator DPVP or any other fully programmable (level and frequency) RF-signal generator.
The subroutine contains a program part which creates a variable waiting time. During this waiting time the second signal generator (the "disturber") can either be set to the measuring frequency manually (SMDU, very fast with synchronizer option SMDU - B 1) or the second signal generator can be programmed to the

proper frequency, which also can take considerable time.
If necessary the waiting time can be varied:

```
9434   FOR   I =  1 TO 2000
9435   NEXT  I
```

Using the number 2000 results in a waiting time of around 10 seconds; if other numbers are used the waiting time changes correspondingly.
The waiting time can also be replaced by a stop in the program for setting the wanted frequency of the secondsignal generator. For this purpose line 9434 is replaced by the order GOS 85.

ATTENTION: Line number 9435 must be erased in this case (See chapter 3.1). By erasing this line with the order: 9435 RETURN the line remains existing but with zero contents; the order "RENUMBER" lets the whole following program 'slide down' filling the empty line.

60: Interchannelmodulation:
For this measurement the SMPU is detuned by two channelspacings and the second signal generator is detuned by one channelspacing. Concerning the set up time for this routine the same procedure is valid as for the routines 58 and 59.

3.12 Comments on Some Subroutines for Transmitter Test

71-76: all measurements of modualtion are being executed depending on the use of the respective subroutines 21, 22 or 23, i.e. AM, FM or ΨM (phase modulation)

79: frequency characteristic of the demodulated audio signal; the measurement is referred to the result of the measurement at 1 kHz and is done at the frequency set up by routine 2. The reference measurement at 1 kHz is contained in routine 79.

82: modulation characteristic:
this routine determines the microphone voltage required for the modulation given by routines 3, 4 and 5 (FM, ϕM, AM). Take care that the level of microphone voltage required for this purpose is within the range of audio voltage the SMPU can generate, i.e. 10 mV to 8 Volts in 10 mV steps.
If the level is lower an attenuator must be inserted and its attenuation must be taken into account for the final result.

3.13 Additional Possibilities for Programming

83 and 84: waiting times:
The subroutines 83 and 84 enable the operator to insert waiting times at any point of the program.

85: stop in the program:
The same is valid for subroutine 85 which stops the program at any point.
Restart or continuation of the program by RETURN .

The order GOTO (address of line) effects the continuation of the program at this addressed line.

EXAMPLE:

```
150     GOTO   300
160     ..........
.
.
.
300     GOS    85
```

Subroutines are called up by the order GOSUP (address of line). The respective subroutines begin at the addressed lines. All orders can be abbreviated to their first three letters.

EXAMPLE:

```
GOSUP  =  GOS
PRINT  =  PRI
```

Subroutines are ended by the order RETURN.

3.14 Weighting of Measurement Results

86: Tolerance evaluation is possible with subroutine 86.
The upper limit is fed in by: H = (upper limit)
The lower limit is fed in by: L = (lower limit)

EXAMPLE: Power measurement with tolerance evaluation, allowable tolerance: 9,5 - 10,2 Watts.

```
100   GOS  68
110   PRI  "POWER:";
120   H  =  10.2
130   L  =  9.5
140   GOS  86
150   PRI  "WATT"
```

If the result is not within the tolerance an extra printout is effected indicating the bad result.
Example for printout: 11 WATT > MAX

3.15 Changing Dimensions of Results

The results of all measurement routines are located at the store Y. The weighting routine 86 also uses Y as storage location. Thus it is always possible to vary the contents of the store Y by some mathematical operation.

EXAMPLE: Output of the result for the modulation characteristic in mV instead of V:

```
100   GOS  82
110   PRI "MODULATION CHARACTERISTIC:";
120   Y  =  Y• 1000
130   GOS  86
140   PRI "mV"
```

The result is then: MODULATION CHARACTERISTIC:
80 mV .

3.16 How to Have Direct Access to the Keyboard of the SMPU Via the Program.

(see Table 2 of the operating manual of the SMPU).

All the keys of the SMPU can be programmed directly using the ASCII-Code by the order:

```
PRI @ 15:   "XXX"
```

EXAMPLE: Switch the SMPU to transmitter test

```
100   PRI @ 15:   "JW"
```

By this feature the operator can write special programs independent of the Basic Software SMPU - K 1 or in combination with it.

4. Structure of Programs

All programs have to start with the subroutine 18:Program start.

```
100   GOS  18
```

If the program is to run only once its end is signalled by

```
1050  END
```

If the program is to run several times the program is finished by

```
1050  GOS  85
1060  GOTO (x = address of line)
```

The address of the line X is the line where the program starts. By pressing the key "RETURN" the program is thus started anew after one run.

ATTENTION: The subroutine 18 (start routine) erases all input data in order to give clearly defined starting conditions. So this routine 18 must be given before the set up procedure of all input data.

5. Starting a Program

The start of a program via the keyboard is done by typing:

```
RUN   X
```

X is the address of the first line of the program.

6. How to Use the Subroutines Directly

All subroutines can be put to operation directly by typing their respective code mumbers on the keyboard of the calculator. So there is no need in this case to write a program and then to call up that program. Instead the codenumber is called up directly by replacing the usual order GOS XX by the order RUN XX.

EXAMPLE: set up of RF-frequency: 123.456 MHz

```
Y = 123,445
RUN 1
```

EXAMPLE: power measurement:

```
RUN 68
Y
```

ATTENTION: If a changeover from a running (normal) program to the direct mode (direct use of subroutines) is wanted, the normal program has to be finished by the order END.
This is useful for tuning procedures in the midst of a normal program.
If a running program is to be interrupted, this can be achieved by pressing the key BREAK and by typing additionally the order END manually.

7. How to Write Special Programs

The operator can either use the ready made programs or he can write programs tailored to his special needs. This task is very much facilitated by the subroutines 87 to 98, which give direct access to the set up data of the SMPU and also to the results of the measurement instruments of the SMPU. The routines 87 to 98 contain no combinations of function or working mode controls, but give the set up data or results directly. Thanks to this feature these routines can be used for any kind of measurements.

89: set up modulation: the routine outputs the set up value for the modulation chosen by routine 21, 22 or 23.

97: af-level: result of one af-level measurement

96: af-noise level: averaged result of several af-level measurements (vital for accurate S/N-measurements).

8. Setting the Addresses of the Instruments Contained in the ATS

The routines of the software SMPU - K 1 only operate in a satisfactory manner if all instruments are set to the correct address within the IEC-Bus System.

	Listener	Talker
SMPU	/	0
PCW for power supply	,(L)	not possible
PCW for control of test item	.(N)	not possible
PCW for second RF-generator	-(M)	not possible

The letters in brackets signify the code on the Coding Board (PCW-Z) of the PCW, which corresponds to the ASCII-sign in the first column.

9. How to Integrate an External Printer into the System

The basic configuration of the System: SMPU + TEK 4051 allows the printout of text and results on the display screen of the 4051. This is done by the order:

PRI "TEXT"

If the external printer is to print the protocol, the order is:

PRI @ 41: "TEXT"

Using an external printer the output routine 86 has to be changed:

old form: output on the display:

```
9296  PRINT"  ", Y, " "
```

new form: output on the printer:

```
9296   PRINT@ 41: " ", Y, " "
```

If both forms or 'printout' shall be used, that is, once on the screen, e.g. for orders for the operator, and once on the external printer for the protocol, then both kinds of orders have to be used.

ATTENTION: The variables

Z, Y, I

are used within the Basic Software and may not be used for other purposes.

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old form: output on the display:

```
9296  PRINT"  ", Y, " "
```

new form: output on the printer:

```
9296   PRINT@ 41: " ", Y, " "
```

If both forms or 'printout' shall be used, that is, once on the screen, e.g. for orders for the operator, and once on the external printer for the protocol, then both kinds of orders have to be used.

ATTENTION: The variables

Z, Y, I

are used within the Basic Software and may not be used for other purposes.

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old form: output on the display:

```
9296  PRINT"  ", Y, " "
```

new form: output on the printer:

```
9296   PRINT@ 41: " ", Y, " "
```

If both forms or 'printout' shall be used, that is, once on the screen, e.g. for orders for the operator, and once on the external printer for the protocol, then both kinds of orders have to be used.

ATTENTION: The variables

Z, Y, I

are used within the Basic Software and may not be used for other purposes.

Input data

1	RF frequency	MHz
2	AF frequency	kHz
3	Frequency deviation	kHz
4	Phase deviation	rad
5	Modulation depth	%
6	AF level	V
7	RF level	dBV
8	Channel number	MHz
9	Channel spacing	kHz
10	Frequency of channel 'n'	MHz
11	Number of channel 'n'	
12	Spacing USB/LSB	MHz
13	IF ±	MHz
14	Supply voltage	V
15	Max. current drain	A
16	Shunt resistance	Ω
17	S/N ratio	dB

Modes

19 Transmitter test
20 Receiver test
21 AM
22 PM
23 FM
24 AM + FM
25 AM + PM
26 AM external
28 Sweeping
29 Analyzer
30 Selfcheck

Test item control

31 Control line set
32 Control line clear
Control line 1
Control line 2
Control line 3
Control line 4
Control line 5
Control line 6
Control line 7
Control line 8
33 BCD channel selection

Receiver measurements

41	dBV -- µV	dBV
42	Sensitivity S/N	dBV
43	Sensitivity SINAD	dBV
44	Sensitivity 20 dB SINAD	dBV
45	Sensitivity 12 dB SINAD	kHz
46	Bandwidth	kHz
	Y2 store upper 6-dB point	kHz
	Y3 store lower 6-dB point	kHz
	Y4 centre shift	kHz
47	Store upper 6-dB point	kHz
48	Store lower 6-dB point	kHz
49	Squelch hysteresis	dB
	Y2 Squelch upper threshold	dBV
	Y3 Squelch lower threshold	dBV
50	Upper squelch threshold	dBV
51	Lower squelch threshold	dBV
52	AF frequency response	dB
53	S/N ratio	dB
54	SINAD ratio	dB
55	Image frequency rejection	dB
56	Duplexer test	dB
57	Duplexer alignment	dB
58	Adjacent channel selection (+)	dB
59	Adjacent channel selection (-)	dB
60	Crosstalk	dB

AF measurements

61	AF level	V
62	Noise level	V
63	AF frequency	kHz
64	DC voltage	mV
65	Distortion factor at 1 kHz	%
66	Distortion factor at 300 Hz	%
67	Current drain	A

Transmitter measurements

68	RF power	W
69	RF frequency	MHz
70	Calling frequency	kHz
71	Pos. modulation	kHz/rad/%
72	Pos. call-modulation	kHz/rad/%
73	Neg. modulation	kHz/rad/%
74	Neg. call-modulation	kHz/rad/%
75	Spurious modulation	Hz/mrad/%
76	Spurious modulation (narrow)	Hz/rad/%o
77	Distortion factor 1 kHz	%
78	Distortion factor 300 Hz	%
79	Frequency response	dB
80	Wideband S/N ratio	dB
81	Weighted S/N ratio	dB
82	Mod. sensitivity	V

Program control

18 Program start
83 Queue organisation 0.1 s.
84 Queue organisation 1 s.
85 Program stop
86 Nominal/actual comparison
H = upper limit value
L = lower limit value
34 Clear

Direct output of test and set values

87	Set RF frequency	MHz
88	Set AF frequency	kHz
89	Set modualtion	kHz/rad/%
92	Set RF level	dB
93	Set AF level	V
94	AF counter	kHz
95	RF counter	MHz
96	AF noise level	V
97	AF level	V
98	Distortion factor	%

Supplement for Chapter 9

Control of an External Printer

Connecting of the Printer SILENT 700 of Texas Instruments:

1) CONNECTING PRINTER AND CALCULATOR

The Printer SILENT 700 is connected via the Option 10 to the desk top calculator TEK 4051.
Set the switch for the baud rate to position 300. (switch mounted on the plug- in case of the option 10).
Furthermore the potentiometer next to the baud-rate switch has to be adjusted to optimal function of the printer, i.e. correct printing of all characters.

Switchsetting on the printer SILENT 700:

a) depress the keys ONLINE and HALFDUPLEX
b) do not depress the key LOWSPEED

NB: The plug- in case of the Option 10 must be inserted into the left slot on the back panel of the TEK 4051 (seen from the front panel side).

2) SOFTWARE

Programming is effected according to chapter 3.15, but with a slight modification:

a) the order: PRINT is replaced by the order:
PRINT @ 41:

The subroutine 86 for weighting the measurement result is intended for the output on the display.
If the output of the weighted result is desired on the printer the subroutine 90 is used accordingly.

The order LINEFEED (new line)
has to be given additionally if an external printer is used.
If the key "LF" is programmed there will be the character J in the protocol of the prgram.

EXAMPLE

output of the power measurement result (weighted)

Line number

```
100       GOS 68
110       PRI @ 41:  "TX-POWER";
120       H = 1Ø,2
130       L = 9,5
140       GOS 90
150       PRI @ 41: "WATT J"
```

3) LISTING OF PROGRAMS

The Subroutine 91 is intended for the listing of the complete measurement program.
The Statement RUN 91 effects the listing of all program steps between line number 100 and line number 9000.

4) LISTING OF PROGRAM PARTS

Using the statement

LIST@ 41: number of first line, number of last line effects the listing of the according program part.

NB: Before using this a.m. statement the calculator must be switched to the proper mode for print out on a printer. This is done by PRI @ 37,26:1

NB: After the printout on the printer the calculator must be switched back to its normal mode. this is done by PRI @ 37,26:0 or by GOS 18

The basic software SMPU-K 1 will not work if the switching back to the normal mode is not done.

EXAMPLE FOR THE LISTING OF PROGRAM PARTS

```
PRI @ 37,26:1
LIST@ 41: 100,600
PRI @ 37,26:0
```

Printout on the printer: line 100 to line 600.

SHORT INSTRUCTION FOR THE COMBINATION OF PROGRAM WITH BASIC-SOFTWARE.

1) Load old program: a, insert cartridge
b, FIND X , wait
c, OLD , wait

X = file number

2) Erase old basic software: a, DEL 1,99
b, DEL 9000,10000

3) Store old program without basic software:
a, FIND x
b, SAVE

4) Load new basic software:
a, insert basic software cartridge
b, FIND 1
c, OLD
d, 100 REM

5) Combination with program:
a, insert program cartridge
b, FIND X
c, Append 100, 8999
d, FIND X
e, SAVE

Key to basic software SMPU-K1 for 4051

No.		Unit
	Input data	
1	RF frequency	MHz
2	AF frequency	kHz
3	Frequency deviation	kHz
4	Phase deviation	rad
5	Modulation depth	%
6	AF level	V
7	RF level	dBV
8	Channel number	
9	Channel spacing	kHz
10	Frequency of channel n	MHz
11	Number of channel n	
12	Spacing USB-LSB	MHz
13	Intermediate frequency +/−	MHz
14	Supply voltage	V
15	Maximum current drain	A
16	Shunt resistance	Ω
17	S/N ratio	dB
	Modes	
19	Transmitter test	
20	Receiver test	
21	AM	
22	PM	
23	FM	
24	AM + FM	
25	AM + PM	
26	External AM	
27	External FM-PM	
28	Sweep	
29	Analyze	
30	Self check	
	Control lines	
31	Control-line set	
32	Control-line clear	
	Control line no. 1	
	Control line no. 2	
	Control line no. 3	
	Control line no. 4	
	Control line no. 5	
	Control line no. 6	
	Control line no. 7	
	Control line no. 8	
33	Channel selection	
	Receiver measurements	
41	dBV − µV conversion	
42	S/N sensitivity	dBV
43	SINAD sensitivity	dBV
44	20-dB SINAD sensitivity	dBV
45	12-dB SINAD sensitivity	dBV
46	Bandwidth	kHz
	Y2 Upper 6-dB point	kHz
	Y3 Lower 6-dB point	kHz
	Y4 Centre-frequency shift	kHz
47	Upper 6-dB point	kHz
48	Lower 6-dB point	kHz
49	Squelch hysteresis	dB
	Y2 Squelch upper threshold	dBV
	Y3 Squelch lower threshold	dBV

No.		Unit
50	Squelch upper threshold	dBV
51	Squelch lower threshold	dBV
52	AF frequency response	dB
53	S/N ratio	dB
54	SINAD ratio	dB
55	Image-frequency rejection	dB
56	Duplexer measurement	dB
57	Duplexer adjustment	dB
58	Adjacent-channel sel. (upper)	dB
59	Adjacent-channel sel. (lower)	dB
60	Crosstalk	dB
	AF measurements	
61	AF level	V
62	Noise level	V
63	AF frequency	kHz
64	DC voltage	mV
65	Harmonic distortion at 1 kHz	%
66	Harmonic distortion at 300 Hz	%
67	Current drain	A
	Transmitter measurements	
68	RF power	W
69	RF frequency	MHz
70	Calling frequency	kHz
71	Pos. modulation	kHz/rad/%
72	Pos. call modulation	kHz/rad/%
73	Neg. modulation	kHz/rad/%
74	Neg. call modulation	kHz/rad/%
75	Spurious modulation (wide)	Hz/mrad/0.1 %
76	Spurious modulation (narrow)	Hz/mrad/0.1 %
77	Harmonic distortion at 1 kHz	%
78	Harmonic distortion at 300 Hz	%
79	Frequency response	dB
80	Wideband S/N ratio	dB
81	Weighted S/N ratio	dB
82	Modulation sensitivity	V
	Program control	
18	Program start	34 Clear
83	Queuing 0.1 s	
84	Queuing 1 s	
85	Program stop	90 as 86 but on
86	Nominal-actual comparison	Printer
	H = upper limit value	
	L = lower limit value	
		91 Program Listing on Printer
	Output of measured and set values	
87	Set RF frequency	MHz
88	Set AF frequency	kHz
89	Set modulation	kHz/rad/%
92	Set RF level	dB
93	Set AF level	V
94	AF counter	kHz
95	RF counter	MHz
96	AF noise level	V
97	AF level	V
98	Harmonic distortion	%

Zusammenstell-Vorschrift Nr. R 30890

für Beschreibung	☐	deutsch	☐	zu Gerät	■
Betriebshandbuch	■	englisch	■	Einschub	☐
mit Grundunterl.	☐	französisch	☐	Anlage	☐
Servicehandbuch	☐			Meßplatz	☐
Rahmenbeschreibung	☐				

Typ SMPU BN 239.0010 FNr. 870 259/1...25

Zusammengest. nach Pos.-Nr.		Register			
Umschlag		4319	(1-10) ☐	PF 095.2687 (21-25)	☐
Karton mit Rückenbindung	☐	4320	(11-20) ☐	PF 095.2693 (26-30)	☐
Schnellhefter PH 079.6430	■	4321	(21-30) ☐	PF 095.2706 (31-35)	☐
Kunststoffordner 40 mm	☐	4322	(31-40) ☐	PF 095.2712 (36-40)	☐
Kunststoffordner 60 mm	☐	PF 095.2641	(1-5) ☐	PF 095.2729 (41-45)	☐
ohne, dafür 4fachlochung	☐	PF 095.2658	(6-10) ☐	PF 095.2735 (46-50)	☐
mit Banderole	☐	PF 095.2664	(11-15) ☐	PF 095.2741 (51-55)	☐
Umschlagbeschriftung		PF 095.2670	(16-20) ☐	PF 095.2758 (56-60)	☐
auf Seite 1 nach Vorlage R				⊐ = doppelseitig drucken	
auf Rücken nach Vorlage R				⊏ = 2 A4 auf A4 drucken	

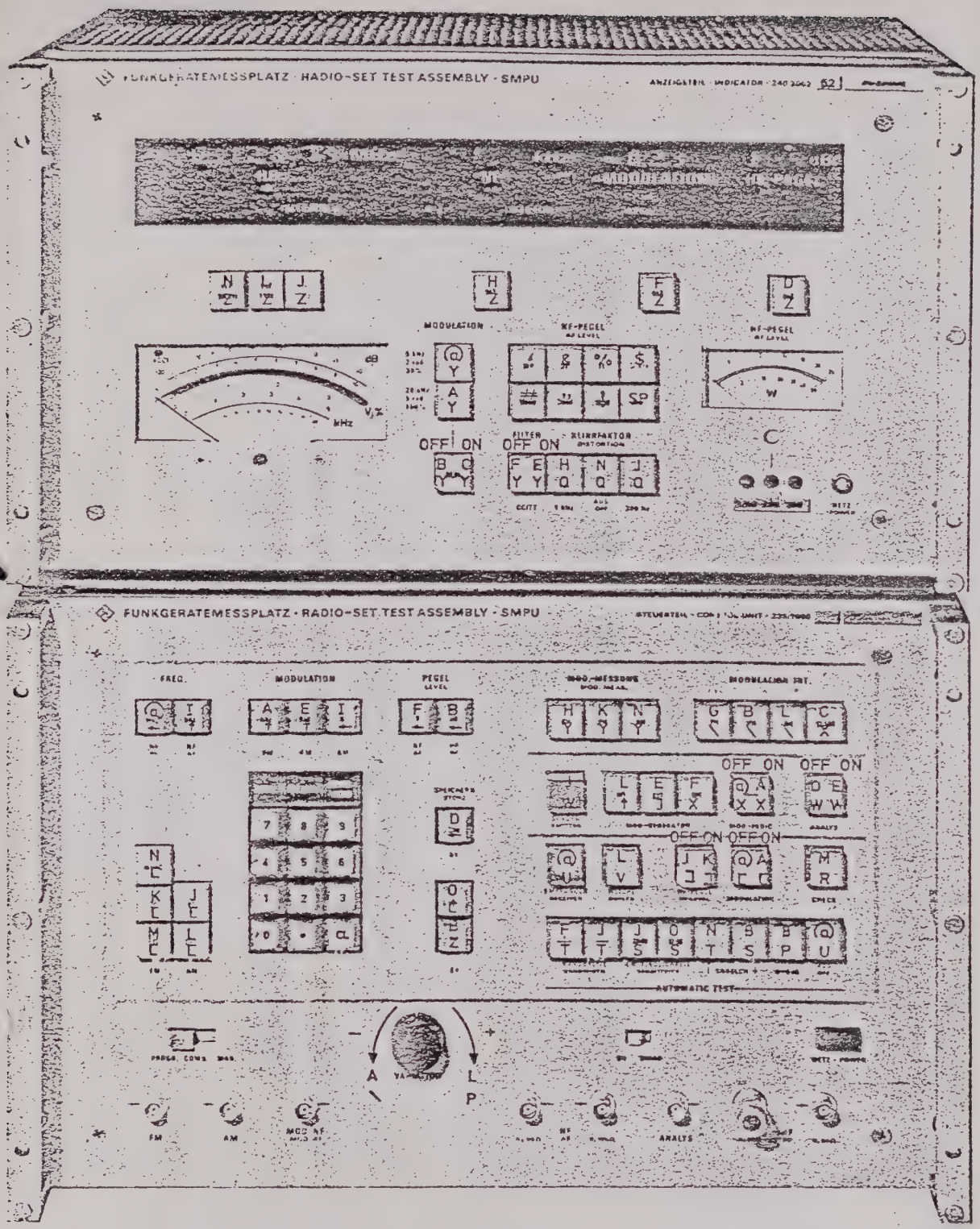
Pos. Nr.	Teil	Sach-Nr.	Blatt-Nr.	ÄZ	Bemerkung
1	Titelblatt	R 30807 -	1		Karton
2	Hinweisblatt	R 14500			
3	Text	R 30807 -	3...39		]
4	Bilder	R 30551	51...52		
5	"	R 30807 -	42		
6	Tabellen	R 30807 -	43...51		]
7	Trennblatt	R			orange
8	Zus.-Vorschrift	R 30890			

5ZIB	Name	Datum	5ZU	Name	Datum
bearb.	Wl	2.9.75	übers.	CN	1.9.75
geschr.	Wl	2.9.75	geschr.	Eck	
geprüft	[signature]	3.9.75			

Liste besteht aus 1 Blatt

R 30890

4463/374 Bl. 1



Befehl	Ausgabe
AW	HF-Frequenz
M←	NF-Frequenz
O←	Variierte Größe
OX	Modulation bzw. NF-Pegel
MX	HF-Pegel
KX	Gleichspannung an ADC-Buchse

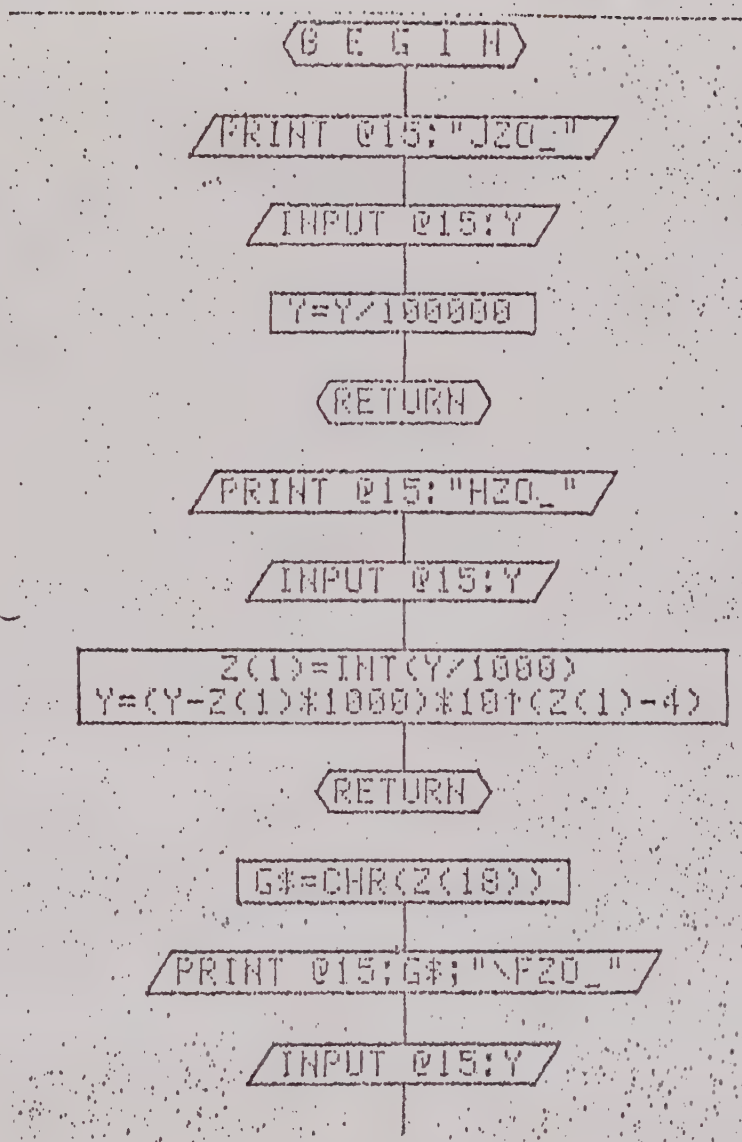
Empfangsadresse: Einstellbefehl siehe Tab. 2-4
Löschbefehl ?

Sendeadresse: Einstellbefehl siehe Tab. 2-4
Löschbefehl ←

Zuordnung der Programmierbefehle zu den Bedienelementen des SMPU

Start
BEGIN
DIM 2220,2240,100
Z=1
DATA 20,94,0,0
RESTORE 1850
READ 2220,2270,HL
WBYTE 947,15:4
PRINT @15;"DUCXBYFYNQJZNI"
RETURN

HF-Leistungsmesser
RF-Power meter



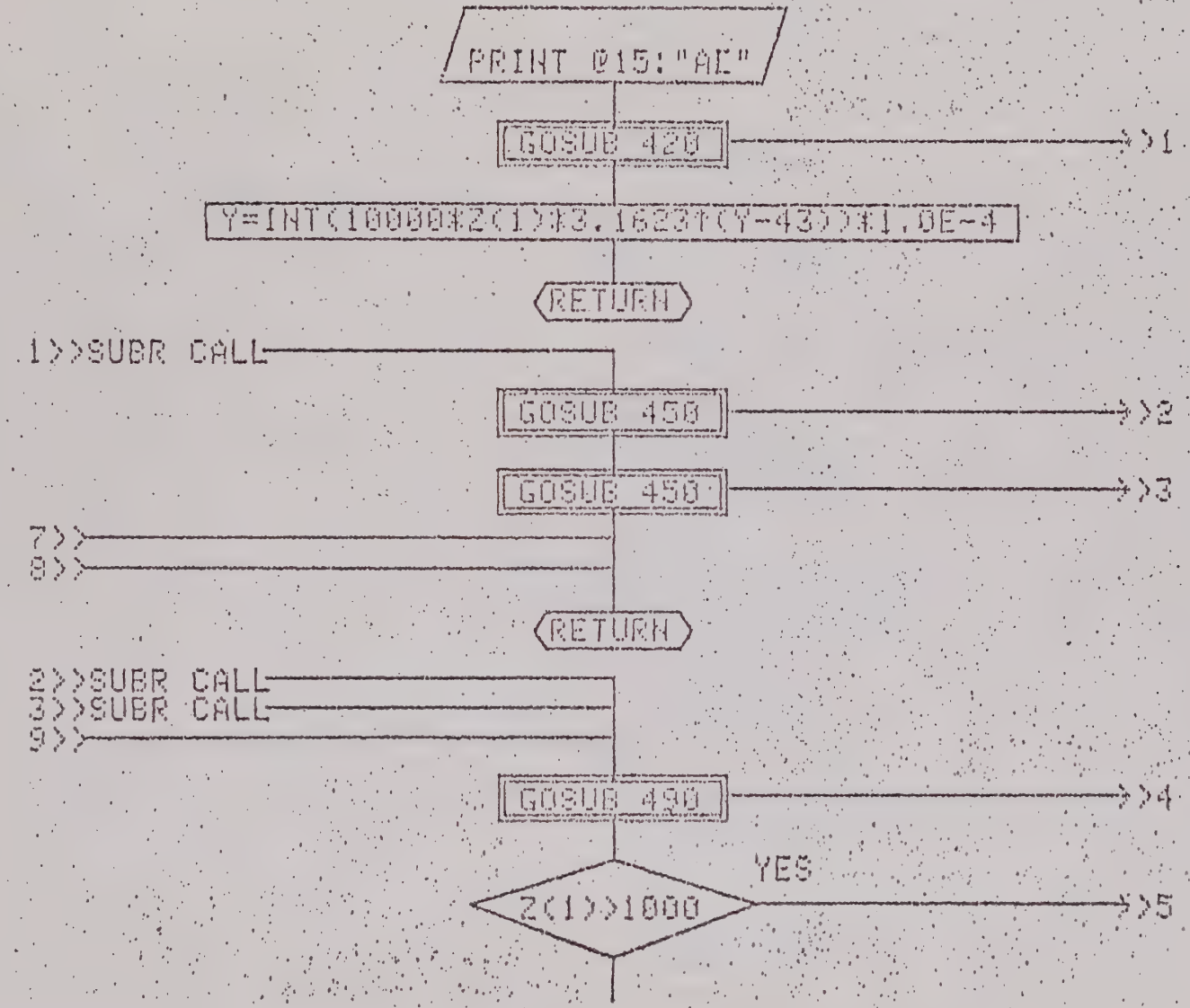
HF-Frequenz
RF Frequency

NF-Frequenz
AF Frequency

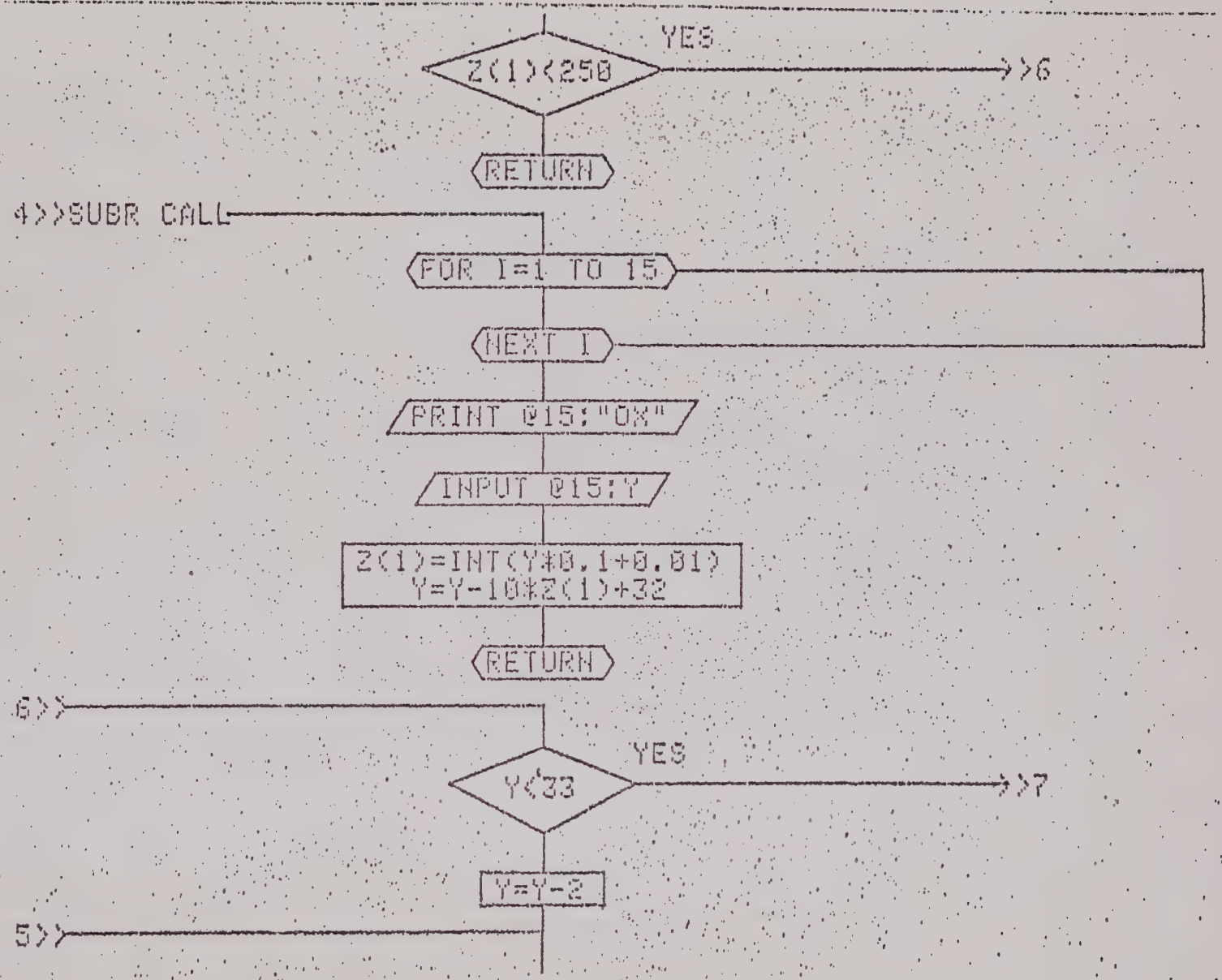
Modulation

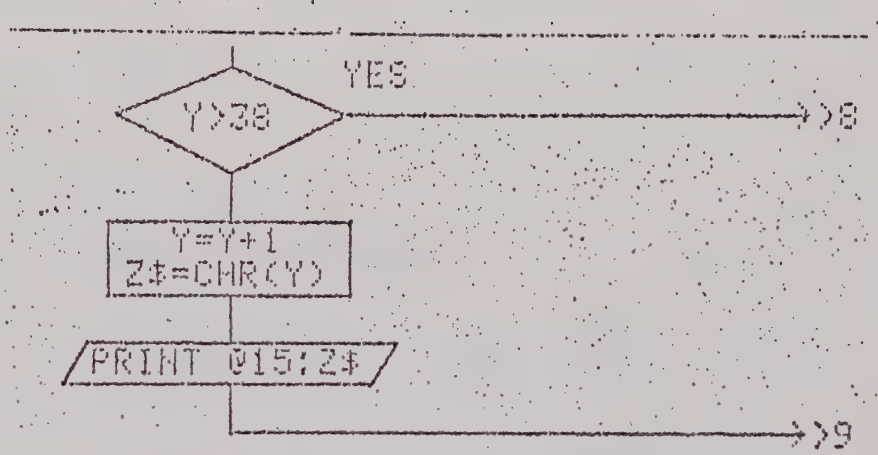
Daten-Ausgabe
Data Output

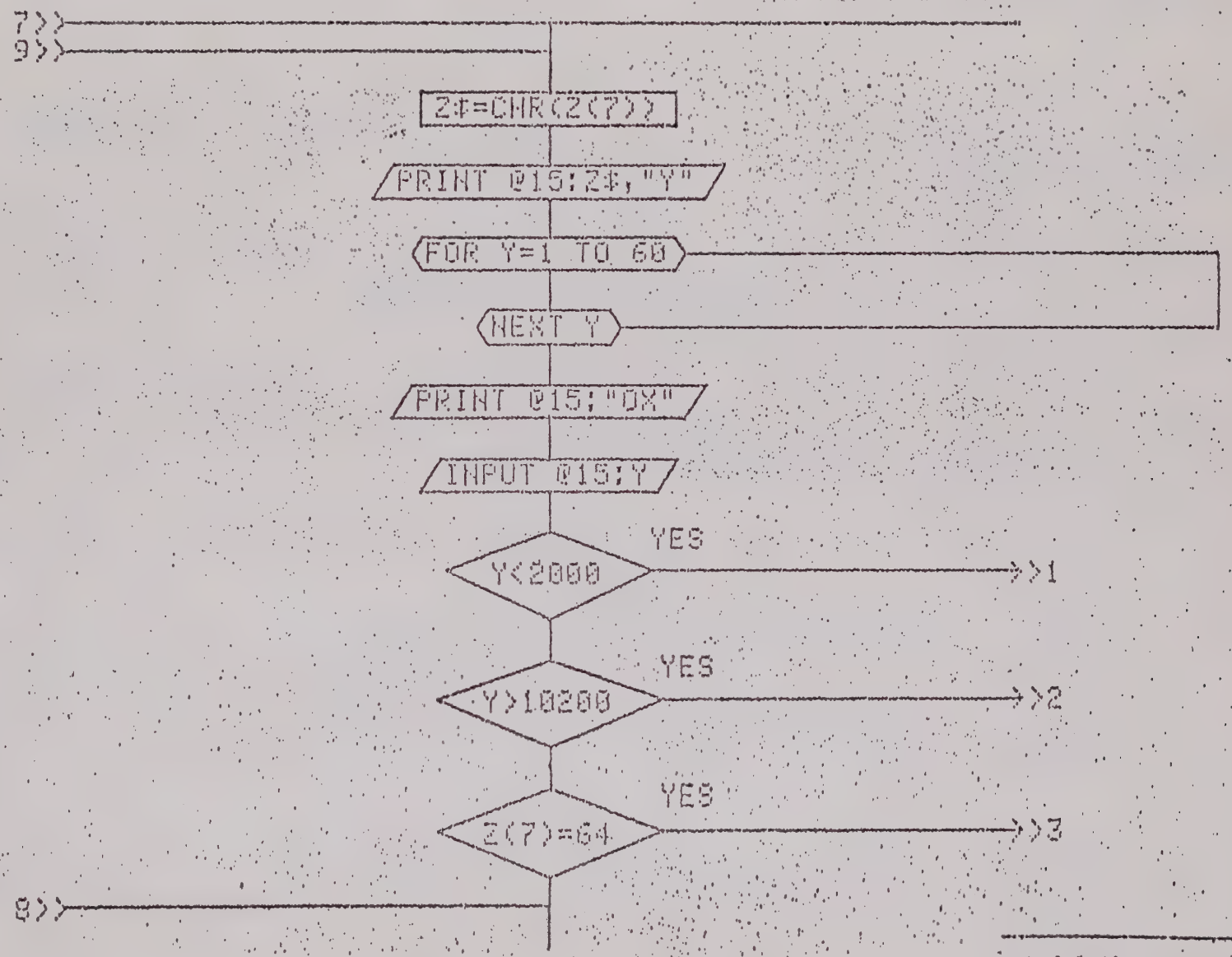
YES
Z(18)=75
Y=Y/10
RETURN



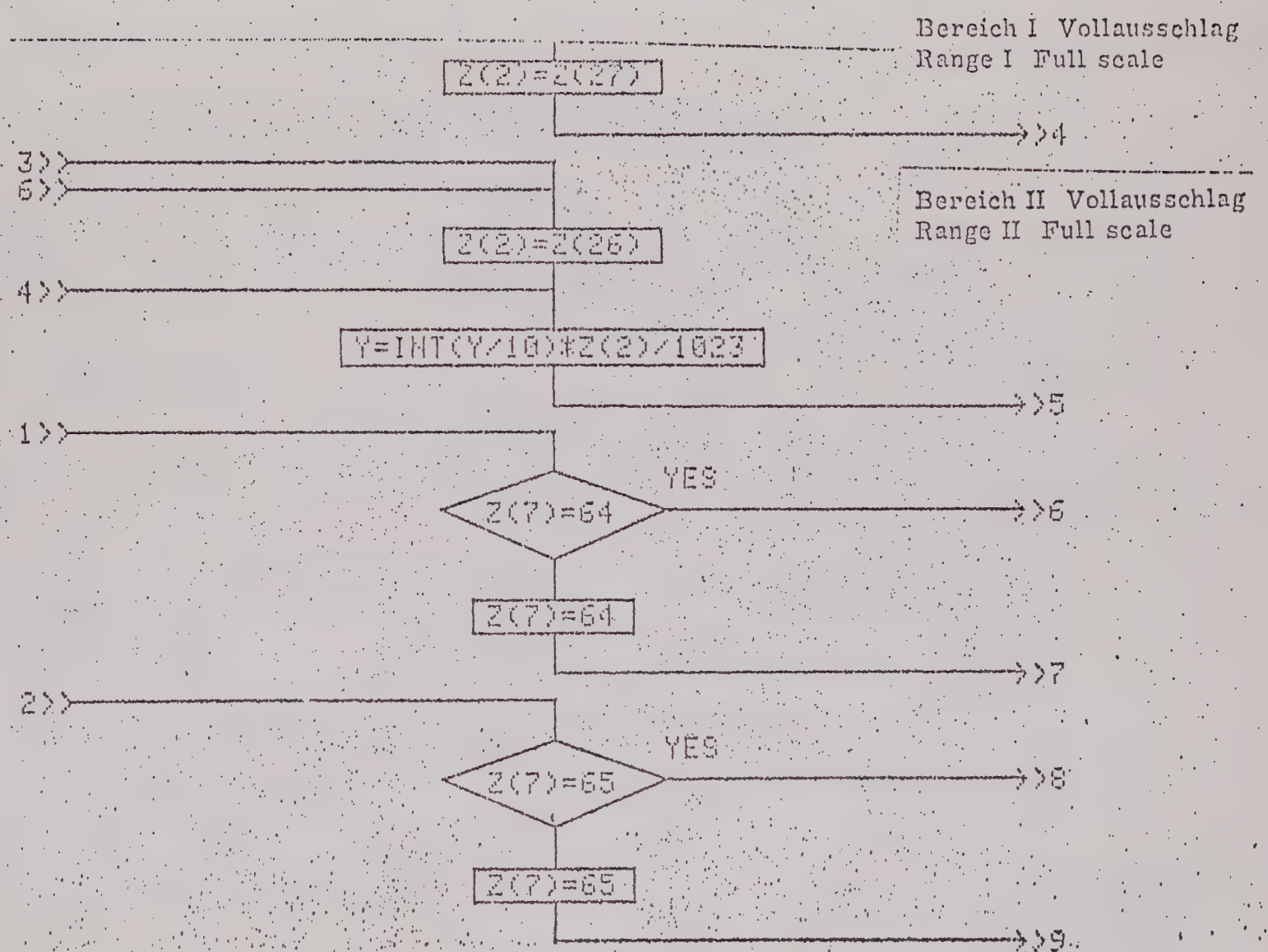
NF-Pegelmesser
AF Level meter

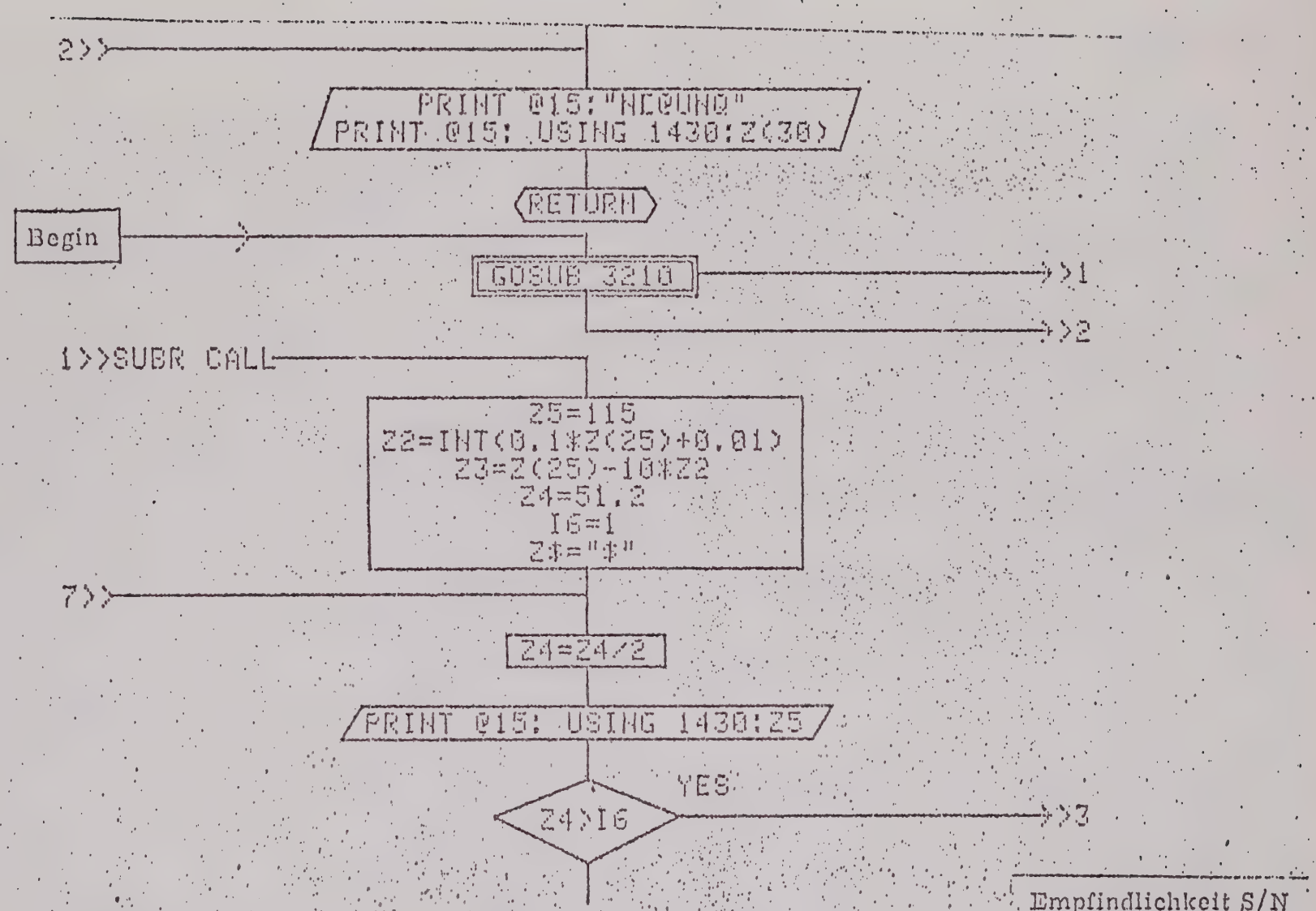

YES
Z(1)<250
>>6
RETURN
4>>SUBR CALL
FOR I=1 TO 15
NEXT I
PRINT @15;"OK"
INPUT @15;Y
Z(1)=INT(Y*0.1+0.01)
Y=Y-10*Z(1)+32
RETURN
6>>
YES
Y<33
>>7
Y=Y-2
5>>


YES
Y>38
>8
Y=Y+1
Z$=CHR$(Y)
PRINT @15;Z$
>9

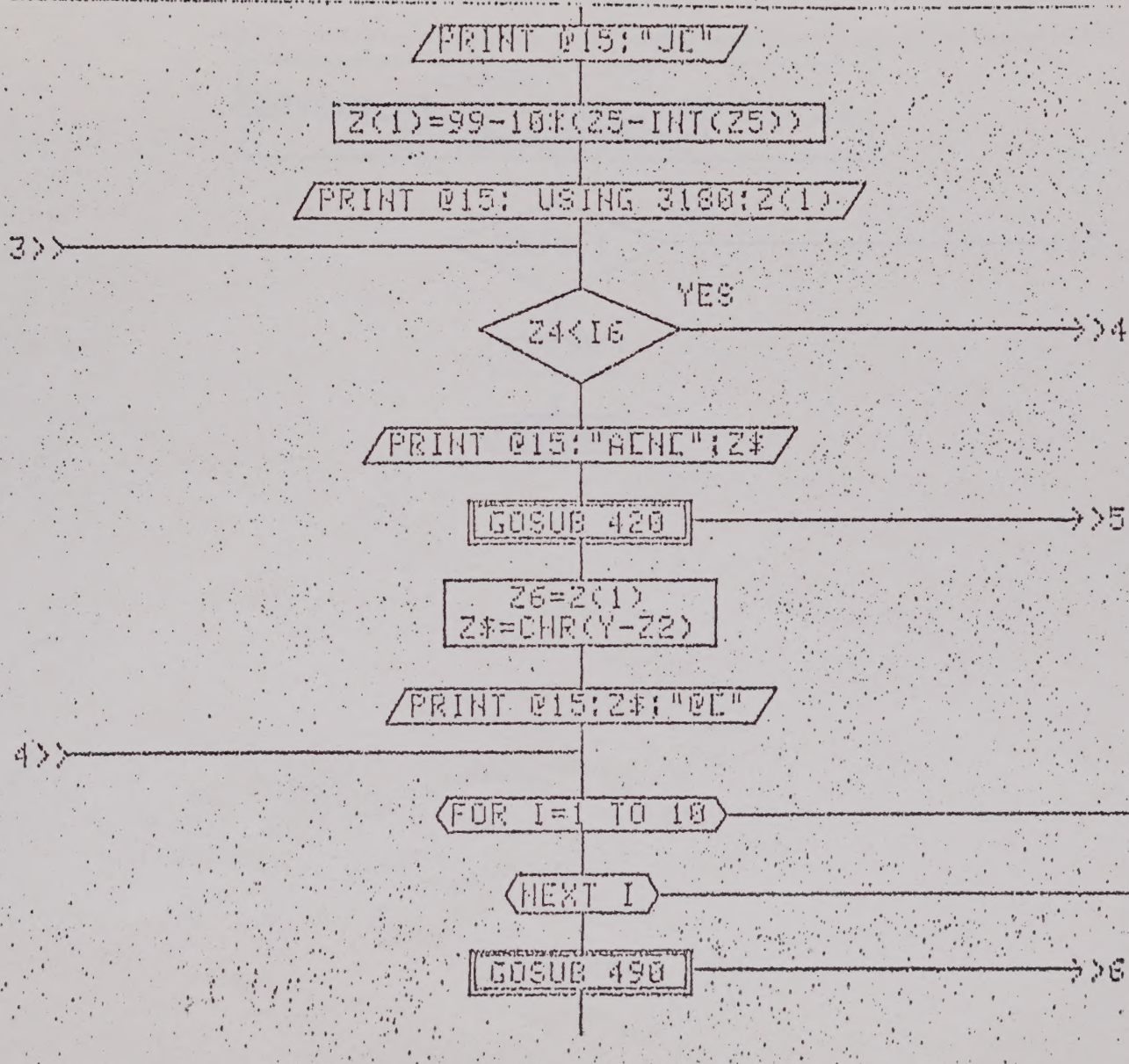


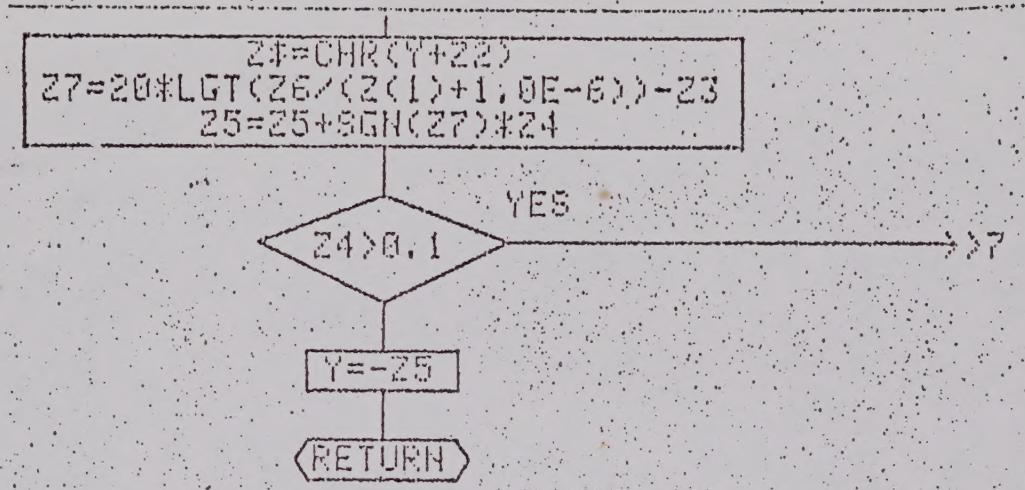
Modulationsmesser
Modulation meter


Bereich I Vollausschlag
Range I Full scale
Z(2)=Z(27)
>>4
3>>
6>>
Bereich II Vollausschlag
Range II Full scale
Z(2)=Z(26)
4>>
Y=INT(Y/10)*Z(2)/1023
>>5
1>>
YES
Z(7)=64
>>6
Z(7)=64
>>7
2>>
YES
Z(7)=65
>>8
Z(7)=65
>>9



Empfindlichkeit S/N
Sensitivity S/N
Z(25) = S/N-Wert
= S/N Value


PRINT @15;"JC"
Z(1)=99-10*(25-INT(Z5))
PRINT @15; USING 3180;Z(1)
3>>
YES
Z4<16
>4
PRINT @15;"ACNC";Z$
GOSUB 420
>5
NF-Pegelmesser
AF Level meter
Z6=Z(1)
Z$=CHR(Y-Z2)
PRINT @15;Z$;"@C"
4>>
FOR I=1 TO 10
NEXT I
GOSUB 490
>6
NF-Pegelmesser
ohne Bereichswahl
AF Level meter
without range contr


Z$=CHR$(Y+22)
Z7=20*LGT(Z6/(Z(1)+1.0E-6))-23
Z5=Z5+SGN(Z7)*24
Z4>0.1
YES
>7
Y=-25
RETURN